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**Work Plan for a  
Corrective Action Study in Support of  
Intrinsic Remediation for Ground Water  
Pol Bulk Fuel Storage Area, IRP Site SS-03**



**Myrtle Beach Air Force Base**

**Prepared For**

**Air Force Center for Environmental Excellence  
Technology Transfer Division  
Brooks Air Force Base  
San Antonio, Texas**

**and**

**Myrtle Beach Air Force Base  
Myrtle Beach, South Carolina**

**December 1994**

*AGMCI-03-0590*

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## SECTION 1

### INTRODUCTION

This work plan, prepared by Parsons Engineering Science, Inc. (Parsons ES), presents the scope of work required for the collection of data necessary to develop a corrective action plan (CAP) for the remediation of ground water contaminated by petroleum hydrocarbons at Installation Restoration Program (IRP) Site SS-03, the Petroleum, Oil, and Lubricant Bulk Storage Area (POL site), at the former Myrtle Beach Air Force Base (AFB) in Myrtle Beach, South Carolina. This work is being conducted for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division under a broad initiative to evaluate the potential for mechanisms of natural attenuation to remediate ground water contaminated with fuel hydrocarbons at Air Force bases nationwide.

Under this CAP, appropriate hydrogeologic and ground water chemical data will be acquired for the evaluation of ground water remediation options. The options to be evaluated will include, but are not limited to, ground water extraction and treatment (i.e. pump and treat); air sparging; and intrinsic remediation with long term monitoring. Intrinsic remediation is a risk-management strategy that relies on natural attenuation to control exposure to risks associated with contaminants in the subsurface. However, this work plan is oriented toward the collection of hydrogeologic data to be used as input into the Bioplume II ground water model in support of intrinsic remediation for the restoration of fuel-hydrocarbon-contaminated ground water.

AFCEE is also developing a corrective action plan (CAP) for a site adjacent to the POL site that is locally known as Site SS-20, or the MOGAS site. The CAP for the MOGAS site is being developed under a nationwide AFCEE initiative to demonstrate how quantitative transport and fate calculations and risk evaluation based on site-specific data can be integrated to quickly determine the type and magnitude of remedial action required at a site to minimize contaminant migration and receptor risks. Because the MOGAS site has contaminants and hydrogeologic characteristics similar to those found at the POL site, data acquired under that CAP, including remediation pilot tests and fate and transport analyses, will be incorporated into this CAP, as appropriate.

As part of the CAP, the Bioplume II modeling effort has three primary objectives: 1) to predict the future extent and concentration of the dissolved contaminant plume by modeling the effects of advection, dispersion, sorption, and biodegradation; 2) to assess the possible risk to potential downgradient receptors; and 3) to provide technical support for selection of the intrinsic remediation option as the best remedial alternative at regulatory negotiations, as appropriate. The Bioplume II modeling effort for this site will involve completion of several tasks, which are further described in this work plan.

This work plan was developed based on a review of the IRP CAP [Law Environmental, Inc. (Law), 1994], Multi-Site Stage 2 Remedial Investigation (Law, 1993), the Phase I Records Search [Engineering-Science, Inc. (ES), 1981], and on the statement of work (SOW) for this project. All field work will follow the health and safety procedures presented in the program *Health and Safety Plan for Bioplume II Modeling Initiative* (ES, 1993) and the site-specific addendum to the program Health and Safety Plan. This work plan was prepared for AFCEE and Myrtle Beach AFB.

## 1.1 SCOPE OF CURRENT WORK PLAN

The objective of the work described herein is to provide an CAP for remediation of ground water contamination at the POL site. However, this project is part of a larger, broad-based initiative being conducted by AFCEE in conjunction with the US Environmental Protection Agency (EPA) and Parsons ES to document natural attenuation of fuel hydrocarbons dissolved in ground water, and to model this attenuation using the Bioplume II numerical ground water model. For this reason, the work described in this work plan is directed toward the collection of data in support of this initiative. These data, along with any additional data required to develop a 30-percent design of an alternate remediation system should intrinsic remediation not prove to be a viable remedial option at this facility, also will be collected under this program. This work plan describes the site characterization activities to be performed in support of the CAP and the Bioplume II modeling effort. Field activities will be performed to determine the extent of residual-phase, free-phase, and dissolved contamination at the POL site. These data will be used along with data from previous investigations to complete the characterization of contaminants at the site and for use in the Bioplume II model to make predictions of the future concentration and extent of contamination.

Site characterization activities in support of the CAP will include: 1) determination of preferential contaminant migration pathways; 2) cone penetrometer (CPT) and laser-induced fluorescence (LIF) testing; 3) monitoring point placement; 4) soil and ground water sampling; and 5) aquifer testing. The materials and methodologies required for collection of these data are described herein. Existing site-specific data and data collected during the supplemental site characterization activities described in this work plan will be used as input for the Bioplume II model. Where site-specific data are not available, conservative values for the types of aquifer materials present at the site obtained from widely accepted published literature will be used for model input. Sensitivity analyses will be conducted for the parameters which are known to have the greatest influence on the results of Bioplume II modeling. The parameters include the hydraulic conductivity of the media, coefficient of reaeration, and the coefficient of anaerobic decay. Where possible, the model will be calibrated using historical site data. Upon completion of the Bioplume II modeling, Parsons ES will provide technical assistance at regulatory negotiations to support intrinsic remediation if the results of the modeling indicate that this approach is warranted. If it is shown that intrinsic remediation is not the most appropriate remedial option, Parsons ES will recommend the most appropriate ground water remedial technology based on available data.

Work that AFCEE will complete at the adjacent MOGAS site includes soil vapor extraction, bioventing and air sparging pilot remediation studies, tracer tests for the evaluation of aquifer characteristics, detailed vertical profiling of contaminants in the

subsurface, and hydrocarbon fate and transport analyses. Results of the MOGAS site work will be integrated into this CAP as appropriate, as the sites share similar hydrogeologic and contaminant characteristics and potential receptors.

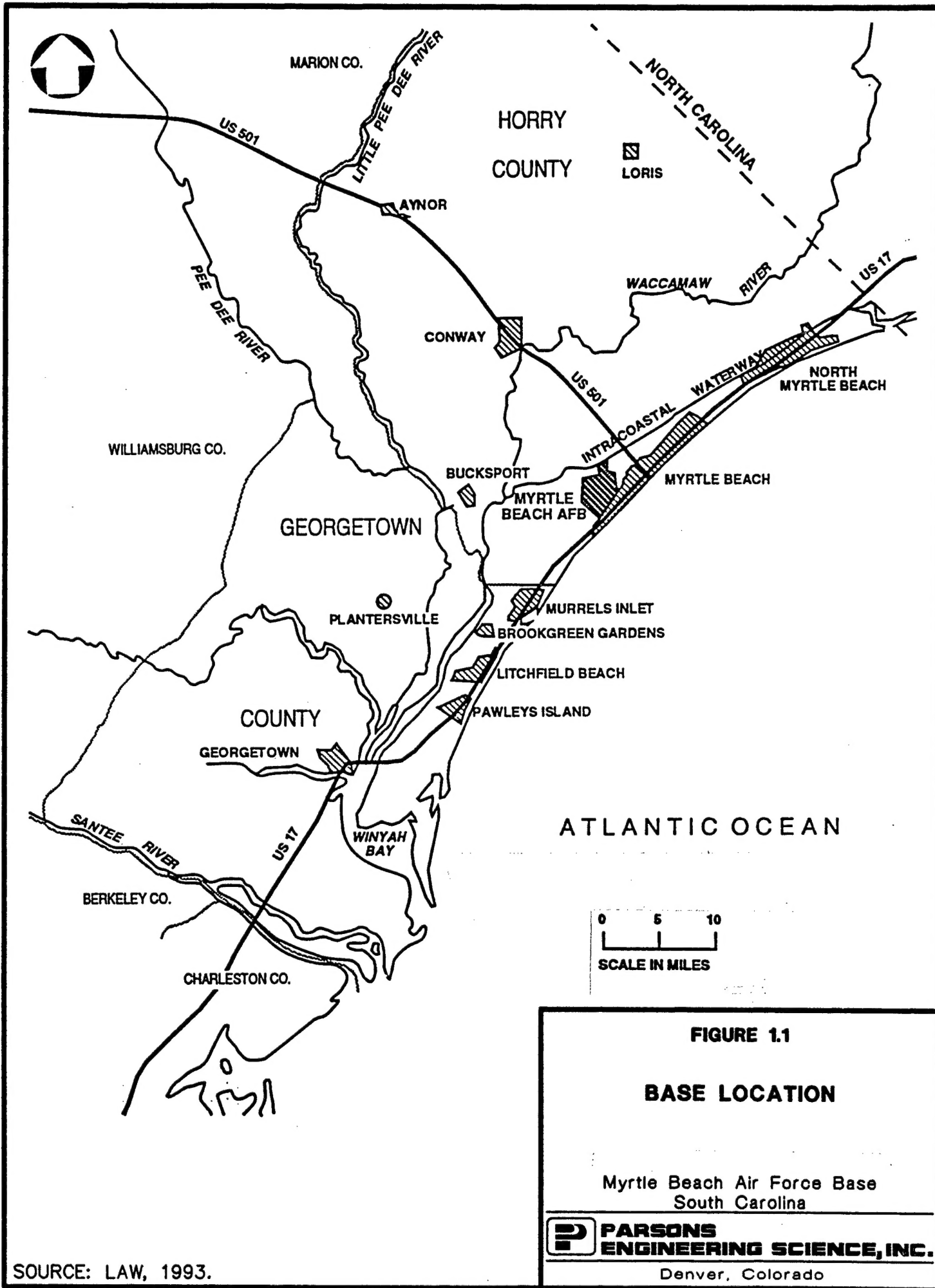
This work plan consists of six sections, including this introduction. Section 2 presents a review of existing site-specific data and a conceptual model for the site. Section 3 describes the proposed sampling strategy and procedures to be used for the collection of additional site characterization data. Section 4 describes the remedial option evaluation procedure and CAP report format. Section 5 describes the quality assurance/quality control (QA/QC) measures to be used during this project. Section 6 contains the references used in preparing this document. There are two appendices to this work plan. Appendix A contains a listing of containers, preservatives, packaging, and shipping requirements for ground water samples. Appendix B contains a summary of existing soil and ground water analytical data from previous field investigations.

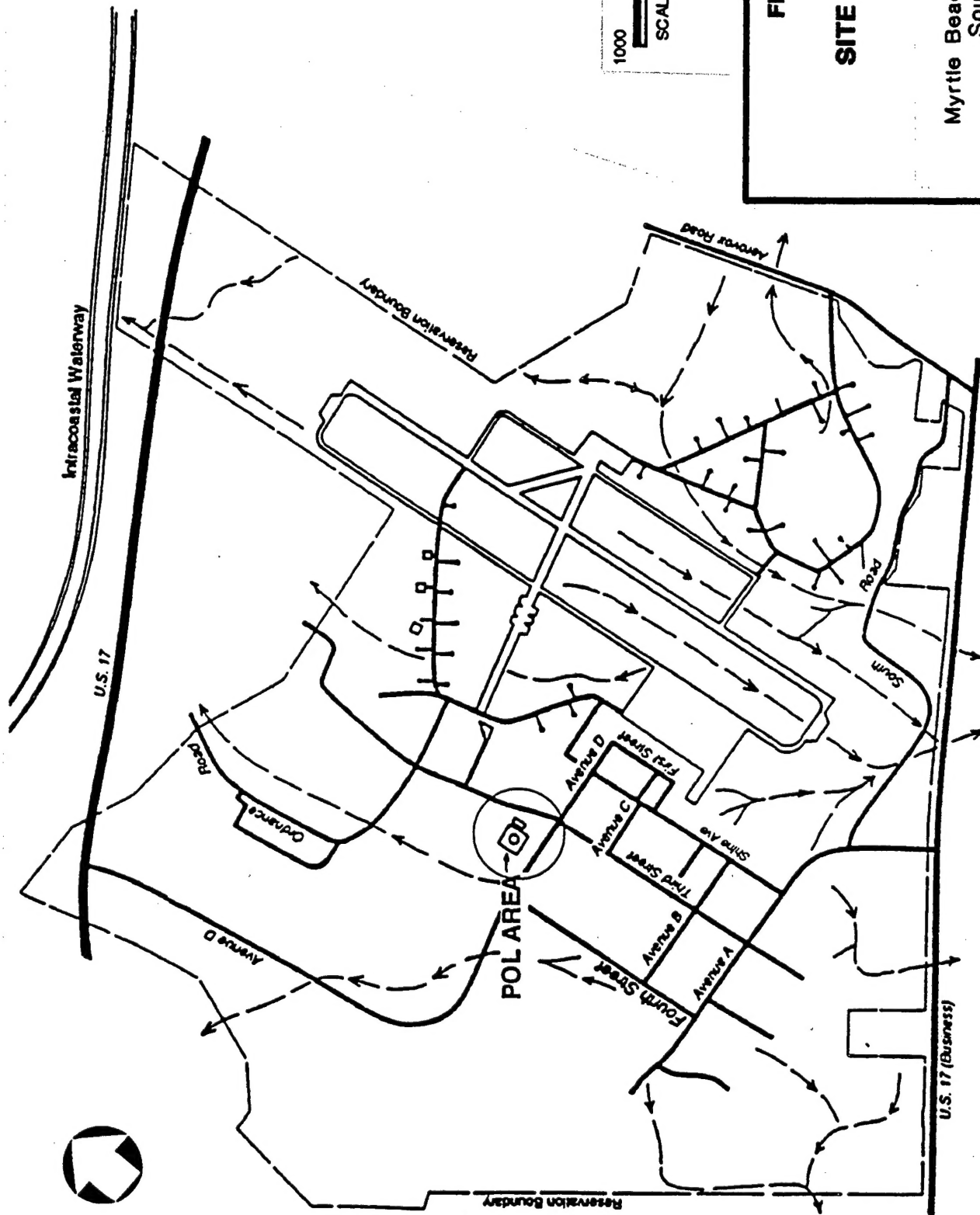
## **1.2 BACKGROUND**

Myrtle Beach AFB is located in Horry County in the northeastern corner of South Carolina, along the Atlantic coast. The base covers an area of approximately 3,793 acres on a strip of land known as the Grand Strand and is bounded on the east southeast by the city of Myrtle Beach and on the northwest by the Intracoastal Waterway (Figure 1.1). The city of Myrtle Beach occupies a narrow strip of land between the base and the Atlantic Ocean, and extends to the north and east of the base. The predominant land use around the base is resort/residential and commercial.

Prior to 1940, the base was used as a municipal airport. Improvements were then made by the Army Air Corps to incorporate the airport into the national defense program. During World War II, units were trained at Myrtle Beach for overseas duty. The base was deactivated during November 1947, and returned to service as a municipal airport. In June 1954, the city of Myrtle Beach donated the airport to the Air Force, and the base returned to active duty. The base was host to the 354th Tactical Fighter Command under the direction of the Tactical Air Command (TAC). It was closed due to budgetary cutbacks in March 1993.

The POL Bulk Fuel Storage Area is located in the northwestern quadrant of the base, west of Third Street and north of Avenue D (Figure 1.2). This storage area was used to supply JP-4 fuel to the aircraft on the flightline via tanker trucks. The POL site is approximately 850 feet by 500 feet and is completely surrounded by a chain-link fence. The northern quadrant of the site is occupied by an east-west traversing road with grass medians. Buildings 522 and 523 are located in this area. Underground jet fuel and gasoline pipelines connect the storage tanks to Building 522, which is the pumping station for the tanker trucks. The site is bounded on the east by Third Street and on the south by a westerly flowing drainage ditch that parallels the north side of Avenue D. A flat, grassy field and a stand of trees lies to the west of the site (Law, 1993). Fuels have not been stored at the POL since base closure; however, many components of the former storage and distribution systems still remain. The most conspicuous remnants of the POL are two steel aboveground storage tanks (ASTs) with floating covers. One tank has a capacity of 1,050,000 gallons and the other has a capacity of 420,000 gallons. Both tanks contained JP-4 jet fuel when in service. Each





**FIGURE 1.2**

**SITE LOCATION**

Myrtle Beach Air Force Base  
South Carolina

**PARSONS**  
**ENGINEERING SCIENCE, INC.**

Denver, Colorado

SOURCE: LAW, 1993.

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AST is surrounded by a secondary containment earthen berm with a volume equal to the capacity of the enclosed tank plus 1 foot of freeboard. There are two 25,000-gallon underground storage tanks (USTs) which are scheduled for removal by the US Army Corps of Engineers (Law, 1994). Both USTs contained gasoline when in use. A 50,000-gallon AST was located to the east of the 1,050,000-gallon AST, but has since been removed. Its former location is shown on the site map (Figure 1.3). There are various underground piping, valves, and pumps associated with transferring the fuels from the tanks to the tanker trucks for delivery. Tanks were emptied and fuel lines were drained before the base was closed in March 1993.

Two releases have been reported at the POL site. Between 1963 and 1967, a 10,000-gallon jet fuel spill was reported to have occurred (ES, 1981). The exact location of the spill is not known. In 1975, a 6-inch fuel supply line was ruptured by a dragline and released an unknown quantity of fuel onto the ground, the spill was contained and was limited to an area of 1,200 square feet (ES, 1981). The former spill area is shown in Figure 1.3.

In 1981, the US Air Force IRP was begun to identify, report, and correct potential environmental deficiencies that could result in ground water contamination and probable migration of contaminants beyond Department of Defense (DOD) installation boundaries. A records search was completed as part of Phase I of the IRP in October 1981 (ES, 1981). At that time, the POL site was identified as a possible source of ground water contamination because of the fuels spilled at the site.

Since 1981, several studies were done to confirm and quantify the contamination at the site. Research Triangle Institute and Geraghty and Miller, Inc. completed the IRP Phase II, Problem Confirmation and Quantification Report in January 1985. Field work was completed between October 1982 and October 1983. Four shallow wells (GM-33, GM-34, GM-35, and GM-36) were installed at depths of 12 to 15 feet. One deep monitoring well, GM-44, was installed at a depth of 35 feet. An IRP Long-Term Monitoring, Stage I Report was completed in June 1990, by Environmental Resources Management, Inc. Each of the above-mentioned five wells were sampled in 1988 for petroleum hydrocarbons. Ground water sampled from GM-35 exceeded the federal maximum contaminant level (MCL) of 5 micrograms per liter ( $\mu\text{g/L}$ ) for benzene.

In June 1993, Target Environmental, Inc. (Target), under the supervision of Law, conducted a shallow soil gas survey, immediately followed by limited shallow ground water characterization in areas where the soil gas survey obtained high readings. Hydrocarbon contamination was noted throughout the site in the soils and ground water. Law executed a follow-up CAP, completed in October 1994. Eleven additional monitoring wells were installed. Soil, ground water, surface water, and sediment samples were taken during this investigation. Light nonaqueous phase liquid (LNAPL) fuel (free product) was discovered in a switch box installed below grade; this fuel was removed during the site investigation.

# LEGEND

- ▲ SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- 25' CONTOUR LINE
- DRAINAGE DITCH
- X — FENCE
- JF — JET FUEL LINE
- GF — GASOLINE FUEL LINE
- SS — STORM SEWER
- S — SANITARY SEWER
- AREA OF 1975 SPILL

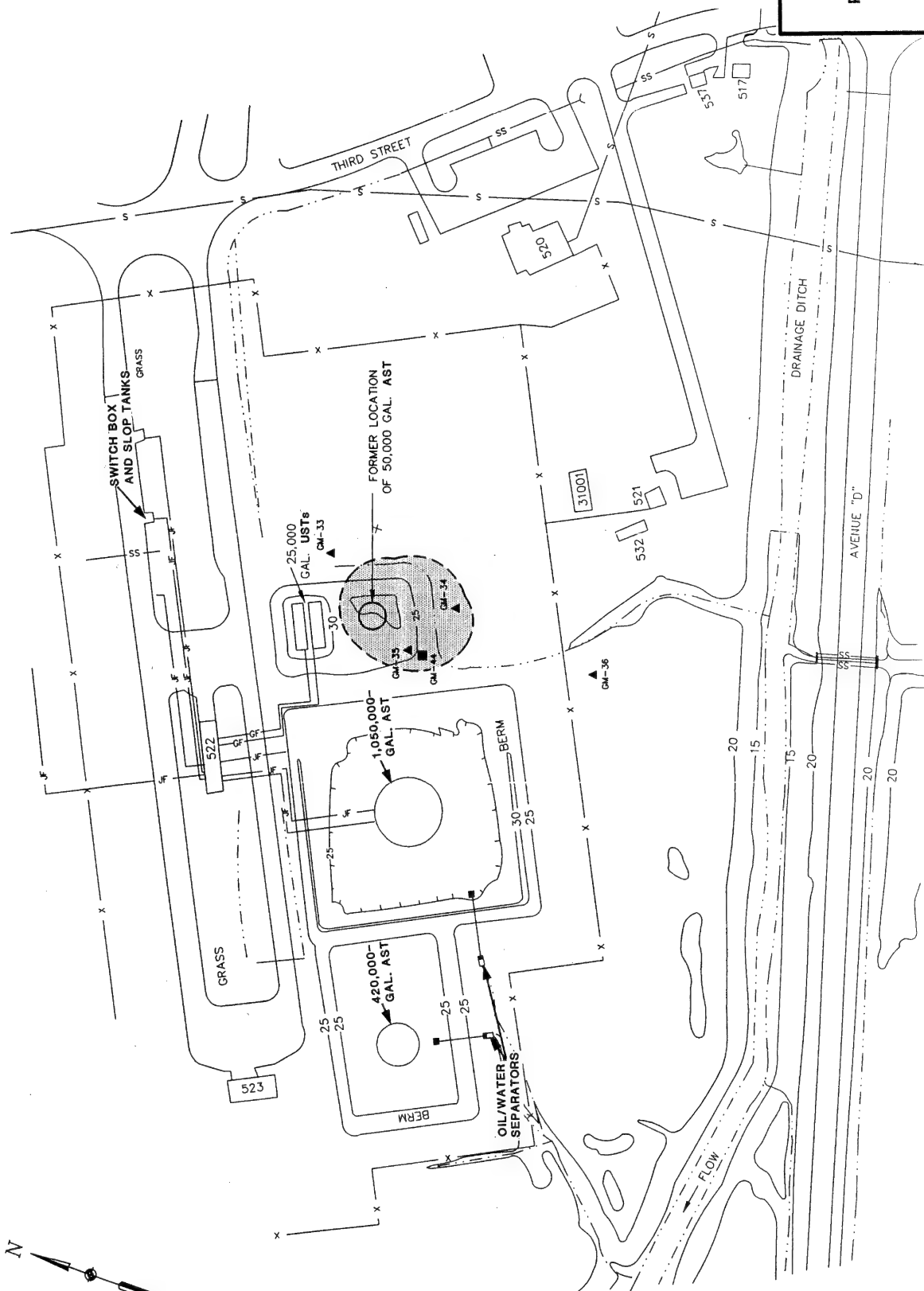


FIGURE 1.3

## SITE LAYOUT POL BULK STORAGE AREA

Myrtle Beach Air Force Base  
South Carolina

**PARSONS**  
ENGINEERING SCIENCES, INC.

Denver, Colorado



## **SECTION 2**

### **DATA REVIEW AND CONCEPTUAL MODEL DEVELOPMENT**

Existing site-specific data were reviewed and used to develop a conceptual model for the ground water flow and contaminant transport at the POL site. This conceptual model guided the development of sampling locations and analytical data requirements needed to support the Bioplume II modeling effort and to evaluate potential remediation technologies, including intrinsic remediation. Section 2.1 presents a synopsis of available site data. Section 2.2 presents the preliminary conceptual ground water flow and contaminant transport model that was developed based on these data.

#### **2.1 DATA REVIEW**

The following sections are based upon review of data from the following sources:

- IRP Site SS-03 Corrective Action Plan (Law ,1994);
- IRP Multi-Site Stage 2 Remedial Investigation (Law, 1993);
- Soil Gas and Ground Water Survey (Target, 1993); and
- IRP Phase I--Records Search, Hazardous Materials Disposal Sites (ES, 1981);

##### **2.1.1 Topography, Surface Hydrology, and Climate**

Myrtle Beach AFB is located within the Sea Island subdivision of the Atlantic Coastal Plain physiographic region (Fenneman, 1938; Colquhoun, 1969). Landforms typical of this zone include plains and hills. The hills lie parallel to the coast, and include sand dunes and wave-cut sand scarp and ridges above mean tide level. The plains lie inland of the hills and are typically flat. The topography of the area is the result of reworked land and marine-derived sediments deposited during fluctuations in sea level. Typical elevations at the Base range from mean sea level to approximately 30 feet above mean sea level (ES, 1981).

The former Myrtle Beach AFB is located on a strip of land known as the Grand Strand, which is surrounded by freshwater and saltwater surface water bodies as shown in Figure 2.1. The Intracoastal Waterway lies approximately 1.7 miles north of the site; 15 miles further west of the site lies the confluence of the Pee Dee and Little Pee Dee Rivers. The Intracoastal Waterway and Waccamaw River converge with the Pee Dee River and subsequently discharge to Winyah Bay at a location approximately 31 miles south of the Base. The Atlantic Ocean lies to the east and south of the Base. A



QUADRANGLE LOCATION

**FIGURE 2.1**  
**LOCATION TOPOGRAPHIC MAP**  
**MYRTLE BEACH AFB**

Myrtle Beach Air Force Base  
South Carolina

**PARSONS**  
**ENGINEERING SCIENCE, INC.**

Denver, Colorado

SOURCE: US Geological Survey, 7.5 Myrtle Beach Quadrangle, 1994.

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low-lying area occupied by lakes, wetlands, a trailer park, and residences lies southwest of the Base.

The Grand Strand is drained by a system of streams and man-made waterways. Drainage from the base flows both north and south, with a drainage divide approximately through the center of the base. Surface runoff from the POL site flows to the south through small swales and storm sewers to the drainage ditch that defines the southern border of the site. Water within the drainage ditch then flows to the west of the POL site. The drainage ditch discharges into the Intracoastal Waterway approximately 1.7 miles north of the POL site.

The climate along the coast of South Carolina is moderated by the Gulf Stream current which brings warm water from the Gulf of Mexico. The temperatures are fairly mild, with a mean annual maximum of 72 degrees Fahrenheit (°F) and a mean annual minimum of 53°F. Temperatures expected during field work scheduled for the months of January and February typically range from a mean high of 59°F to a mean low of 37°F. The relative humidity averages about 88 percent (Detachment 3, 3rd Weather Wing, 1942-1947 and 1949-1981). Precipitation averages 49.8 inches per year with approximately 107 days of precipitation each year. Although precipitation is spread fairly evenly throughout the year, maximum precipitation typically occurs during the summer months (July through September). The mean annual wind speed is 6 knots.

## **2.1.2 Overview of Geology and Hydrogeology**

### **2.1.2.1 Regional Geology and Hydrogeology**

The shallow subsurface geology of the Myrtle Beach area consists of the Socastee Formation and its associated units: the Myrtle Beach Barrier sediments and the Myrtle Beach Backbarrier sediments (ES, 1981). The Myrtle Beach Barrier sediments are composed of well-sorted fine to coarse sands, which formed dunes parallel to the shoreline in the backshore and aeolian dune environments. These sediments are well drained and highly permeable. Ground water is typically encountered at depths of 5 feet or less. The Myrtle Beach Backbarrier sediments are composed of sands with interlayered clays, silty sands, and clayey sands which occupy the flatlands behind the barrier zone. These sediments are typically deposited in a lagoonal or shallow estuarine environment that is periodically inundated by washover fans during storm events. Locally, the Backbarrier sediments are underlain by the Myrtle Beach Barrier sediments. The Backbarrier sediments generally have low to moderate permeability, poor drainage, and a high water table due the large amount of fines present.

The Socastee Formation is described by Glowacz *et al.* (1980), as fine to coarse sands, argillaceous and silty sands, and clays; deposited under littoral, marsh, and estuarine conditions. The Socastee has an abrupt, irregular, and unconformable contact with the underlying Canepatch Formation. The base of the Socastee is approximately 20 feet below mean sea level (msl) at the coast and gradually grades upward to 25 feet above msl at its furthest inland extent, approximately 9 to 10 miles to the west.

Subsurface geology in the Myrtle Beach area is composed of Quaternary-, Tertiary-, and Cretaceous-aged sediments (Glowacz *et al.*, 1980). In descending order, the Quaternary units include undifferentiated Holocene sediments, the Socastee, the Canepatch, and the Waccamaw Formations. These sediments are unconsolidated in the Myrtle Beach area. The Tertiary Bear Bluff and Duplin Formations underlie the Quaternary deposits and were deposited in an open marine environment. The Duplin Formation appears as an erosional remnant of sandy limestone and calcareous silty sand of variable thickness, and may be absent in some areas. Below these sediments in order of increasing age are the Upper Cretaceous-aged Pee Dee, Black Creek, and Middendorf Formations. These formations represent a regressive sequence of fluvial to estuarine to open marine depositional environments.

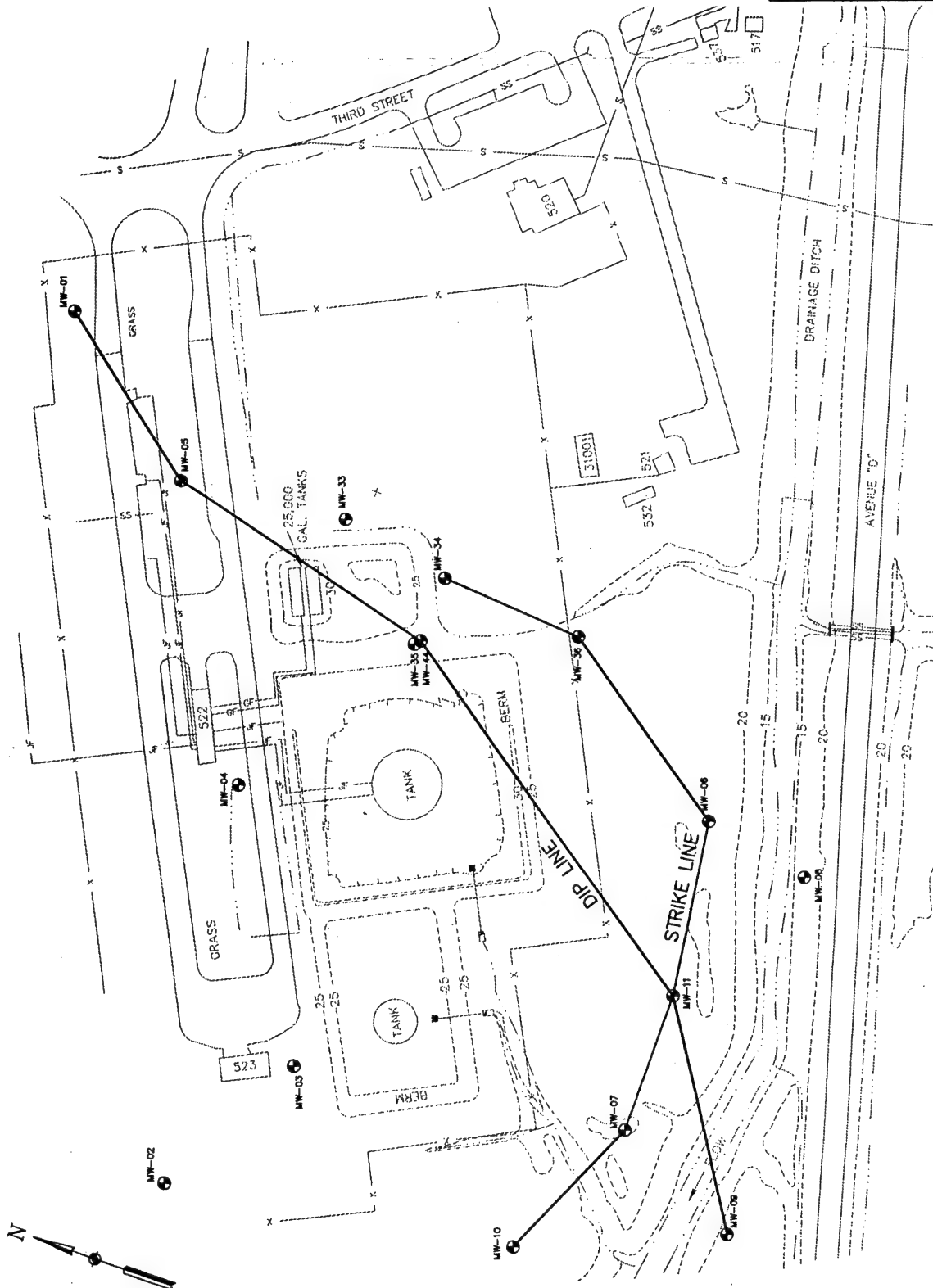
The regional strike in this study area is generally northeast-southwest, with the formations gently dipping to the southeast. This gentle dip is the result of regional downwarping of the basement rock and sediments along the coast. This downwarping results in sedimentary units that tend to thicken downdip toward the coast. The sediments thin inland and outcrop in the Upper Coastal Plain, west of Myrtle Beach.

The regional hydrogeology of the Myrtle Beach area consists of the unconfined aquifer and several confined aquifers at depth. The unconfined aquifer consists of approximately 100 feet of interlayered sediments that may include parts of all of the facies belonging to the Holocene Undifferentiated, Socastee, Canepatch, Waccamaw, Bear Bluff, and Duplin Formations. This hydrologic unit typically acts as a water-table (unconfined) aquifer, but may be confined locally for short distances (ES, 1981). The water table is usually encountered within 5 feet of the ground surface, and is often used as sources of domestic and irrigation water. Recharge of the aquifer occurs throughout the area by infiltration of precipitation where permeable zones are exposed. The deeper confined aquifers are made up of three separate units: the Pee Dee, Black Creek, and Middendorf Systems. Both the Pee Dee and the Black Creek systems are used extensively as a source of potable water. The Middendorf is not used as a source of potable water due to high concentrations of chlorides.

#### **2.1.2.2 POL Bulk Fuel Storage Site Geology and Hydrogeology**

Sediments at the POL site consist primarily of fine- to coarse-grained sands interbedded with layers and lenses of clay. Sands range from silty/clayey to well sorted and clean, indicative of fluctuating episodes of low to high energy depositional environments and sediment source areas. Thick zones of soft, plastic, dark clays and sandy clays are also found within the POL site. Figure 2.2 shows the POL site and the locations of two stratigraphic cross-sections. Figure 2.3 is a cross-section of the site in the general direction of the regional dip. Figure 2.4 is a cross-section approximately perpendicular to the dip line and generally follows the direction of regional strike. These two cross-sections detail the interlayering of clays and sands characteristic of this type of depositional environment.

In April 1994, Law took measurements of ground water elevations and calculated *in-situ* hydraulic conductivities from slug tests at the POL site. Monitoring well construction details and ground water elevations for the POL site are provided in



**LEGEND**

- 25 — TOPOGRAPHIC CONTOURLINE (FT MSL)
- — — DRAINAGE DITCH
- — — FENCE
- JF — JET FUEL LINE
- GF — GASOLINE FUEL LINE
- SS — STORM SEWER
- S — SANITARY SEWER
- MONITORING WELL

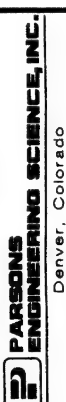
ELEVATIONS REPORTED IN FT MSL

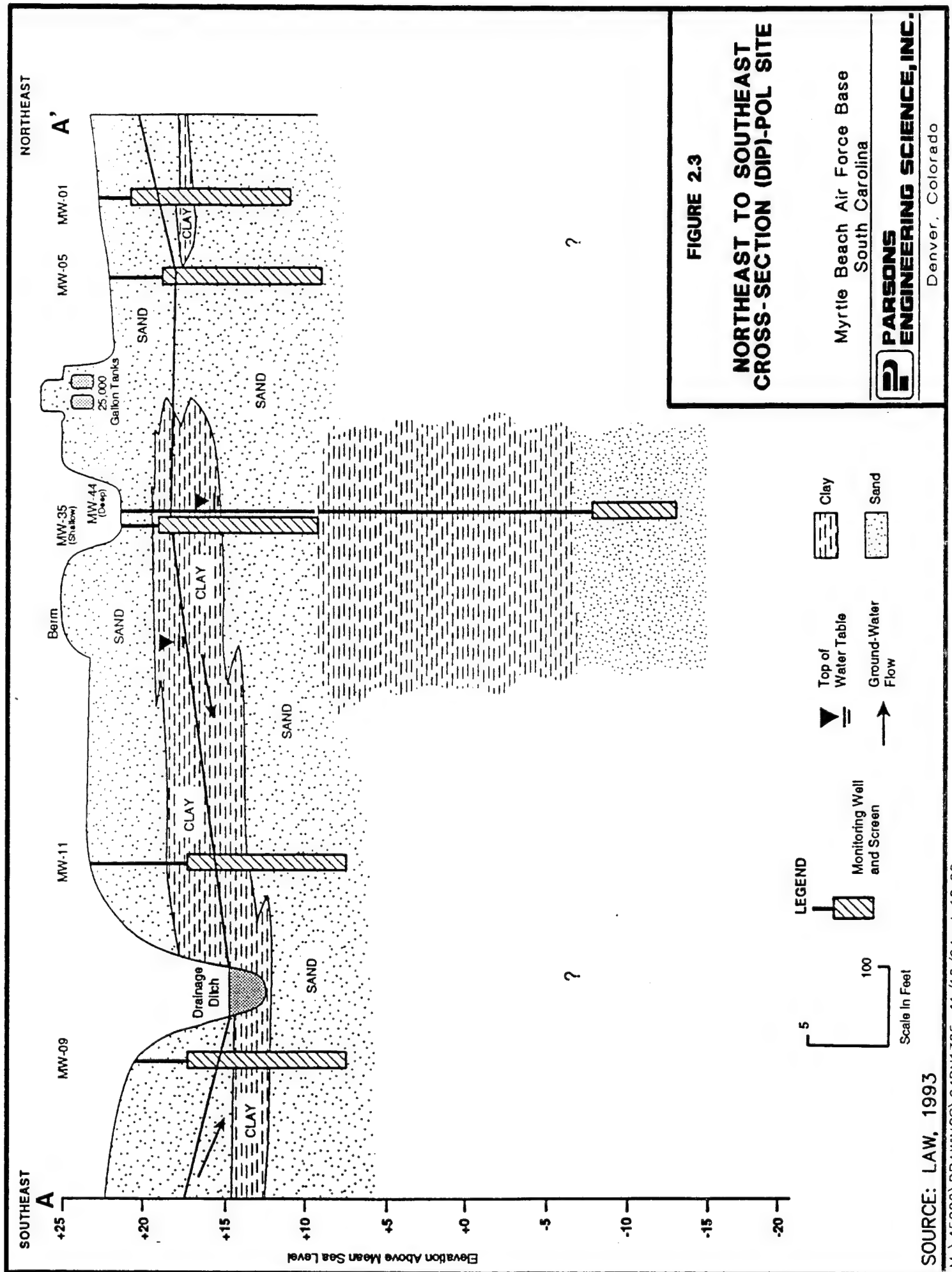


**FIGURE 2.2**

**LINE OF CROSS-SECTIONS  
POL SITE**

Myrtle Beach Air Force Base  
South Carolina





SOUTHWEST  
B

NORTHEAST  
B'

MW-10

MW-07

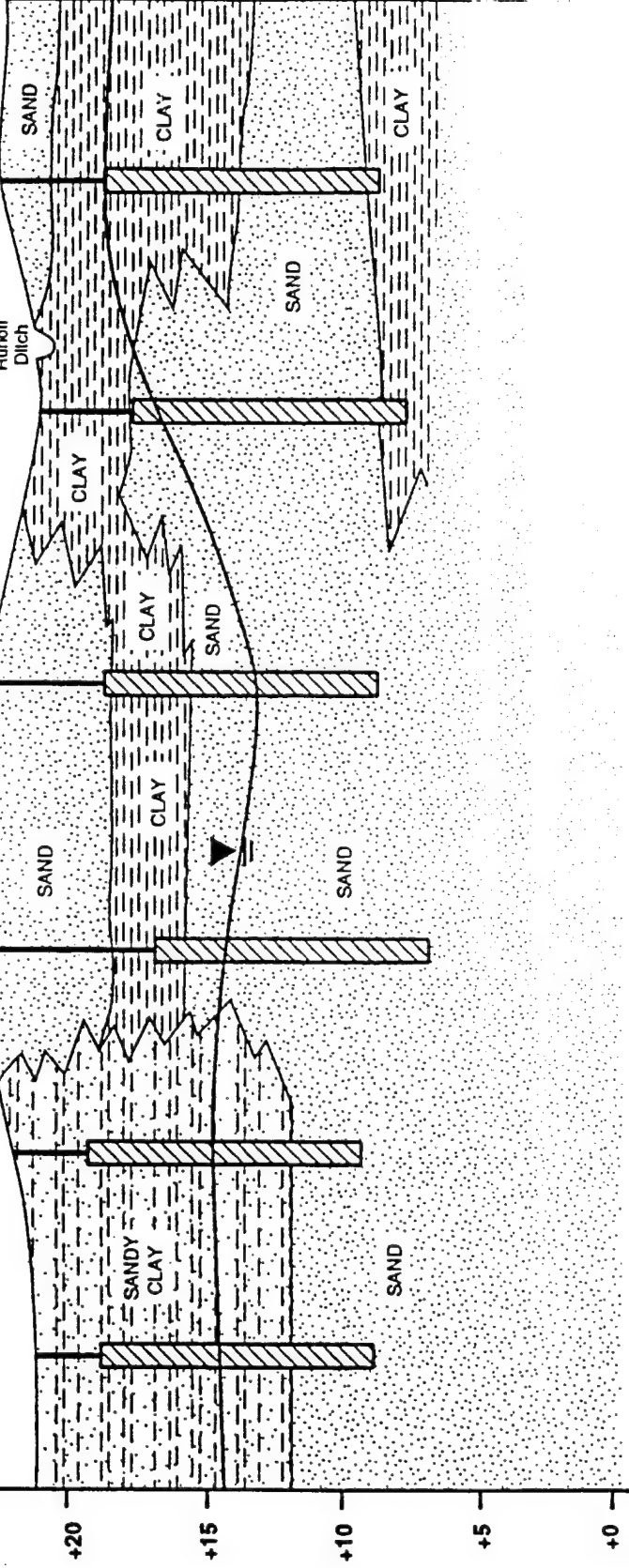
MW-11

MW-06

MW-36

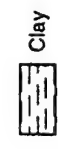
MW-34

Runoff Ditch

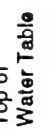


Elevation Above Mean Sea Level

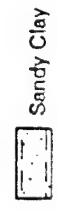
LEGEND



Clay



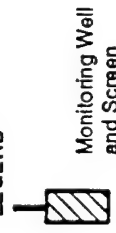
Sand



Sandy Clay



Top of Water Table



Monitoring Well and Screen



Scale in Feet

FIGURE 2.4

**SOUTHWEST TO NORTHEAST  
CROSS-SECTION (STRIKE)-POL SITE**

Myrtle Beach Air Force Base  
South Carolina



**PARSONS  
ENGINEERING SCIENCE, INC.**

Denver, Colorado

SOURCE: LAW, 1993

M:\45022\DRAWINGS\QADMT 306 11/10/94 at 10:00



Tables 2.1 and 2.2, respectively. Figure 2.5 shows the ground water surface for the POL site in April 1994. Flow direction is determined to be south-southwest from the POL site to the westward flowing drainage ditch on the southern border of the site. In the western quadrant of the site, the flow direction is to the west-southwest. The local ground water flow direction is generally perpendicular to the drainage ditch throughout the site. South of the drainage ditch, the local flow direction is also toward the drainage ditch, to the north. Because the ditch is deep enough to intersect the water table (Figure 2.3), it acts as a discharge point for ground water. The drainage ditch discharges into the Intracoastal Waterway to the north of the base.

The hydraulic gradient was determined to be 0.006 foot per foot (ft/ft), and the hydraulic conductivity determined from monitoring wells MW-01 through MW-11 ranged from  $1.7 \times 10^{-3}$  to  $5.8 \times 10^{-3}$  foot per minute (ft/min) [ $3.9 \times 10^{-4}$  to  $1.1 \times 10^{-3}$  centimeters per second (cm/s)] (Law, 1994). The effective porosity at the site was estimated to be 0.30 based on the lithology at the site (Law, 1994). From the above information and estimated values, the seepage velocity at the POL site was determined to range from 8.2 to 23.5 feet per year.

### 2.1.3 Soil Quality

#### 2.1.3.1 Soil Gas Survey

In June 1993, a soil gas survey was performed by Target Environmental under the supervision of Law to determine the extent of hydrocarbon fuel contamination and to identify locations where additional soil borings and monitoring wells should be placed at the POL site. Seventy-seven soil gas samples were collected and analyzed with a flame ionization detector (FID) for the following volatile organic compounds (VOCs): dimethylbenzene, chlorobenzene, dichloroethene, and benzene, toluene, ethylbenzene and xylenes (BTEX). The results of the soil gas survey indicate the presence of petroleum hydrocarbons throughout the subsurface at the site (Figure 2.6).

High concentrations of VOCs were noted at several locations, indicating areas where underground pipeline leaks or surface spills may have occurred in the past. An area of high VOC concentration ( $> 100,000$  ppbv) extends from the south side of Building 522 to the USTs, and from the USTs north to an underground jet fuel line (Figure 2.6). High VOC concentrations are located directly south of Building 522 and the underground jet fuel line.

Another area of high concentrations surrounds the site of the removed 50,000-gallon AST. An unknown quantity of fuel was spilled in this area from a 6-inch supply line in 1975. The area of high VOC concentrations extends to the south of the removed AST and the 1,050,000-gallon AST berm, and terminates at the drainage ditch, where a sheen on the water surface and stressed vegetation on the banks were observed in June 1993.

Two additional areas of high soil gas concentrations are located south and north of the berm surrounding the 420,000-gallon AST. The southern area is located near the outlet of the oil/water separator (Figure 1.3). The northern area is located between the



**TABLE 2.1**  
**SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS**  
**POL SITE**

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Well ID	Completion Date	Well Material	Elevation		Top of Filter Pack		Top of Well Screen		Bottom of Well Screen		Bottom of Well	
			TOC ft MSL a/	GS ft MSL b/	Depth ft bgs c/	Elev ft MSL	Depth ft btoc d/	Elev ft MSL	Depth ft btoc	Elev ft MSL	Depth ft btoc	Elev ft MSL
MW-01	3/14/94	2" PVC	25.13	23.03	0.50	22.53	2.89	22.24	12.88	12.25	13.44	11.69
MW-02	3/14/94	2" PVC	24.59	22.33	2.00	20.33	4.87	19.72	14.88	9.71	15.44	9.15
MW-03	3/14/94	2" PVC	24.97	22.83	1.50	21.33	4.39	20.58	14.39	10.58	14.95	10.02
MW-04	3/14/94	2" PVC	26.17	23.98	2.50	21.48	6.32	19.85	16.31	9.86	16.87	9.30
MW-05	3/21/94	2" PVC	24.09	22.22	1.50	20.72	4.87	19.22	14.89	9.20	15.45	8.64
MW-06	3/14/94	2" PVC	25.52	23.06	4.00	19.06	6.33	19.19	16.32	9.20	16.88	8.64
MW-07	3/14/94	2" PVC	24.67	22.00	1.20	20.80	5.00	19.67	14.99	9.68	15.55	9.12
MW-08	3/22/94	2" PVC	23.69	20.78	3.00	17.78	7.17	16.52	17.18	6.51	17.74	5.95
MW-09	3/22/94	2" PVC	22.24	20.03	1.00	19.03	5.02	17.22	15.04	7.20	15.62	6.62
MW-10	3/13/94	2" PVC	23.25	21.10	1.00	20.10	4.35	18.90	14.25	9.00	14.83	8.42
MW-11	3/26/94	2" PVC	26.05	23.42	3.00	20.42	8.82	17.23	18.83	7.22	19.39	6.66

a/ Top of Casing; Feet Above Mean Sea Level.

b/ Ground Surface; Feet Above Mean Sea Level.

c/ Feet Below Ground Surface.

d/ Feet Below Top of Casing.

**TABLE 2.2**  
**SUMMARY OF GROUND WATER LEVEL MEASUREMENTS**  
**POL SITE**

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Sample Location	Sample Date	Easting	Northing	Datum Elevation (ft msl) b/	Depth to Water (ft TOC) c/	Depth to Product (ft TOC)	Product Thickness (feet)	Corr. Depth to Water a/ (ft TOC)	Corr. GW Elevation (ft msl)
MW-01	3/26/94	NA d/	NA	25.13	4.52	- e/	-	4.52	20.61
	4/11/94	NA	NA	25.13	5.47	-	-	5.47	19.66
MW-02	3/18/94	NA	NA	24.59	7.74	-	-	7.74	16.85
	4/11/94	NA	NA	24.59	8.51	-	-	8.51	16.08
MW-03	9/28/94	NA	NA	24.97	6.94	-	-	6.94	18.03
	4/13/94	NA	NA	24.97	8.11	-	-	8.11	16.86
MW-04	3/18/94	NA	NA	26.17	8.06	7.37	0.69	7.54	18.63
	4/11/94	NA	NA	26.17	9.02	7.84	1.18	8.14	18.04
MW-05	9/28/94	NA	NA	24.09	4.87	3.54	1.33	3.87	20.22
	4/13/94	NA	NA	24.09	5.56	4.27	1.29	4.59	19.50
MW-06	3/18/94	NA	NA	25.52	11.81	-	-	11.81	13.71
	4/13/94	NA	NA	25.52	11.95	-	-	11.95	13.57
MW-07	9/28/94	NA	NA	24.67	8.85	-	-	8.85	15.82
	4/13/94	NA	NA	24.67	9.67	-	-	9.67	15.00
MW-08	3/18/94	NA	NA	23.69	9.37	-	-	9.37	14.32
	4/13/94	NA	NA	23.69	9.53	-	-	9.53	14.16
MW-09	9/28/94	NA	NA	22.24	7.13	-	-	7.13	15.11
	4/13/94	NA	NA	22.24	7.49	-	-	7.49	14.75
MW-10	3/18/94	NA	NA	23.25	8.41	-	-	8.41	14.84
	4/13/94	NA	NA	23.25	8.83	-	-	8.83	14.42
MW-11	9/28/94	NA	NA	26.05	11.50	-	-	11.50	14.55
	4/13/94	NA	NA	26.05	11.77	-	-	11.77	14.28

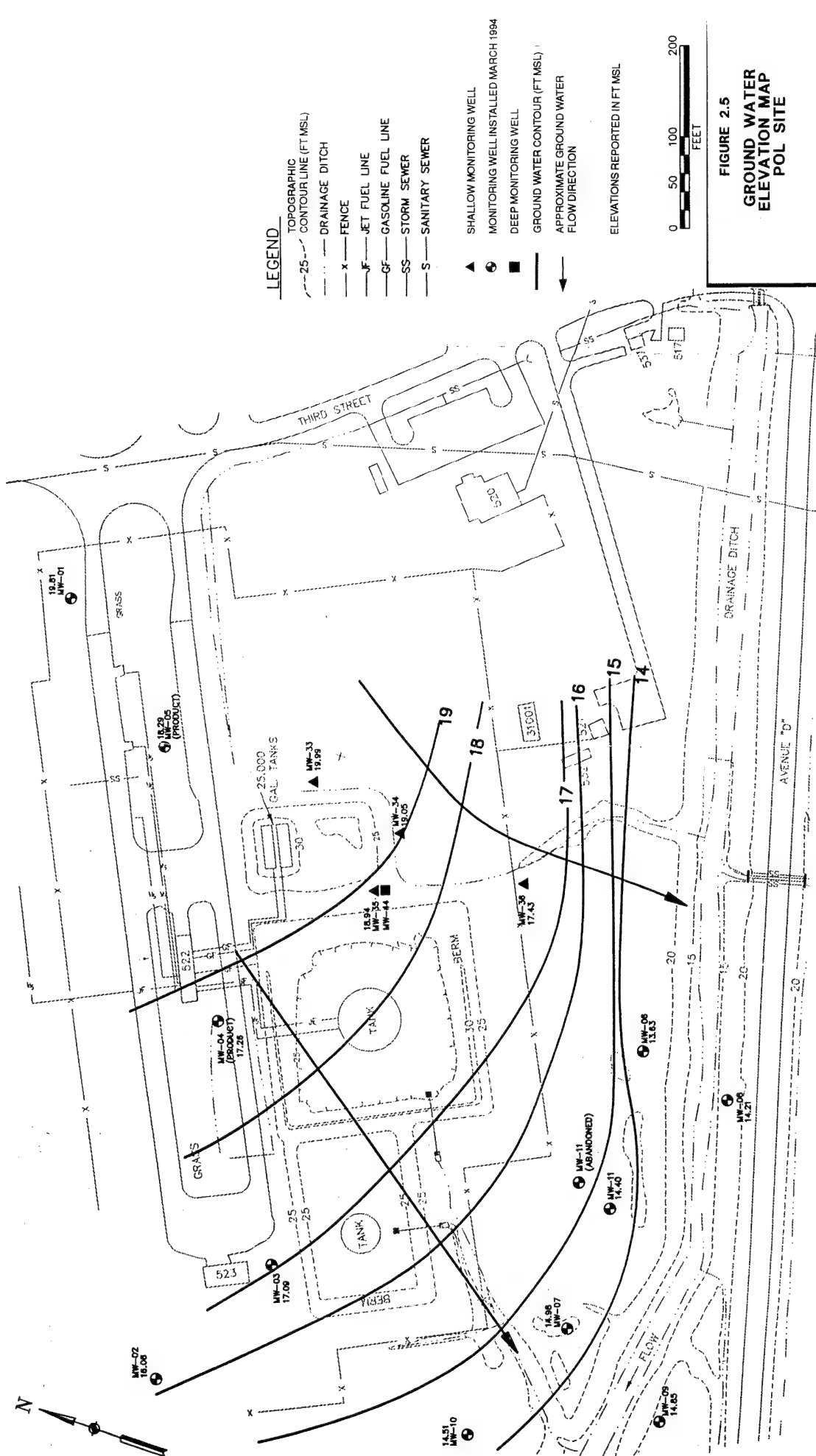
a/ Corrected Depth to Water = Measured Depth to Water - (0.75 x Product Thickness)

b/ Feet Above Mean Sea Level

c/ Feet Below Top of Casing

d/ Not Available

e/ Not Applicable



# LEGEND

- SOIL GAS SAMPLING POINTS
- ▲ SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- 25 TOPOGRAPHIC CONTOUR LINE (FT MSL)
- - - DRAINAGE DITCH
- - - FENCE
- - - JET FUEL LINE
- - - GASOLINE FUEL LINE
- - - STORM SEWER
- - - SANITARY SEWER
- - - ISOPLETH AND CONCENTRATION

SC001	360	SC40	280,200
SC002	178,600	SC41	21,690
SC003	184,500	SC42	18,450
SC004	1,792	SC43	322,722
SC005	156,400	SC44	6,974
SC006	196	SC45	78
SC007	184,400	SC46	14,064
SC008	184,400	SC47	78
SC009	218,320	SC48	48,250
SC010	18,300	SC49	42,340
SC011	207	SC50	28,300
SC012	224	SC51	41
SC013	13,600	SC52	13,600
SC014	<10	SC53	1,822
SC015	<10	SC54	1,824
SC016	<10	SC55	312
SC017	<10	SC56	107,731
SC018	4,121	SC57	3,034
SC019	2,120	SC58	2,856
SC020	7,227	SC59	4,976
SC021	13,370	SC60	2,489
SC022	71	SC61	2,489
SC023	18	SC62	289,285
SC024	<10	SC63	4,276
SC025	<10	SC64	2,869
SC026	1,245	SC65	11
SC027	<10	SC66	184,566
SC028	<10	SC67	2,639
SC029	<10	SC68	95
SC030	15	SC69	13,741
SC031	118	SC70	<10
SC032	17,741	SC71	13,740
SC033	12	SC72	<10
SC034	608	SC73	<10
SC035	<10	SC74	10
SC036	<10	SC75	19
SC037	<10	SC76	14
SC038	<10	SC77	<10
SC039	<10	SC78	<10



FIGURE 2.6  
ISOPLETH MAP OF  
TOTAL VOC CONCENTRATIONS  
IN SOIL GAS  
POL SITE

Myrtle Beach Air Force Base  
South Carolina



Denver, Colorado

berm and Building 523. The reason for the high concentration to the north of the berm is unknown. The high soil gas concentrations near the oil/water separator may have resulted from leaks or spills associated with the separator itself. Nearby hydrocarbon-stained soil indicates surface spillage.

#### **2.1.3.2 Soil Borings and Hand Auger Borings**

Soil samples collected from hollow-stem auger and hand-augered soil borings were sent to the analytical laboratory for chemical analysis. BTEX were analyzed using EPA Method SW8020; polynuclear aromatic hydrocarbons (PAHs) were analyzed using EPA Method SW8310; and total petroleum hydrocarbons (TPHs), which include the semivolatile diesel fuel, JP-4, and JP-5 compounds, were analyzed using EPA Method SW8015 modified. Tables 2.3 and 2.4 summarize BTEX naphthalene, and TPH results for the soil boring and hand-augered samples, respectively. Appendix B contains a complete summary of analytical data from the site CAP (Law, 1994).

The analytical results for soil samples from the soil borings and the hand-augered borings confirm the results of the soil gas survey. The hand-augered data indicate high BTEX concentrations on the south side of the pumping station at Building 522 and the fuel lines leading to the two 25,000-gallon USTs. There are also high concentrations of BTEX present at HA-08 and -09 near the switch box and slop tank in the northwestern quadrant of the site. Both of these areas are near soil borehole locations that were converted to monitoring wells (MW-04 and MW-05) and later found to contain free product. The soil sample collected at SB-01 collected between 4 and 6 feet below ground surface (bgs) had the highest BTEX concentration, at 1,370 milligrams per kilogram (mg/kg). This location coincides with the soil staining near the drainage ditch where a sheen was noticed in June 1993.

Elevated TPH and PAH (naphthalene makes up the majority of the PAH concentrations) were also detected at the locations of elevated BTEX concentrations. These data further confirm the presence of fuel hydrocarbons in the subsurface, particularly in the area of SB-01 near the location where a hydrocarbon sheen was observed along the drainage ditch during June 1993. Concentrations of 20,000 mg/kg TPH and 28 mg/kg naphthalene were detected in the soil sample from soil borehole SB-01. Elevated TPH and PAH concentrations also were detected in samples collected near the switch box at HA-09 (TPH concentration of 19,000 mg/kg and a PAH concentration of 40.2 mg/kg).

#### **2.1.4 Water and Sediment Quality and Chemistry**

##### **2.1.4.1 Ground Water**

Ground water samples from 14 of the 16 monitoring wells at the site vicinity were collected and analyzed for BTEX, TPH, and PAHs during the POL assessment in April 1994 (Law, 1994). Nine ground water samples were collected from the POL area and analyzed in the field for BTEX and total FID VOCs in June 1993 (these samples are referred to as the ground water screen results). Wells MW-04 and MW-05 contained free product and were not sampled. The free product thicknesses in these wells were

TABLE 2.3  
SUMMARY OF DETECTED FUEL CONSTITUENTS IN SOIL SAMPLES  
POL SITE

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Analyte	SB-01 3/22/94 4-6' bgs	SB-02 3/11/94 6-8' bgs	SB-03 3/11/94 6-8' bgs	SB-04 3/11/94 0-2' bgs	SB-05 3/11/94 4-6' bgs	SB-06 3/21/94 4-6' bgs	SB-07 3/12/94 4-6' bgs	SB-08 3/12/94 2-4' bgs	SB-09 3/12/94 4-6' bgs	SB-10 3/12/94 4-6' bgs	SB-11 3/12/94 2-4' bgs
Aromatic Volatiles											
SW8020 (mg/kg)											
Benzene	<14JD c/ 260JD	0.0067 0.01	ND a/ 0.0024	ND	<0.013 0.63	0.009 0.0055	<5JD 16JD	.88JD <0.5JD	0.23 2JD	<0.13JD 5.7JD	ND ND
Toluene	920JD	0.062	0.028	0.0013	4.7J b/ 0.17	0.044 <0.0025	54JD <5JD	23JD <0.5JD	6.4JD <0.025	10JD <0.13JD	ND ND
Ethylbenzene	190JD	0.0038	0.0009	0.003							
Xylenes											
PAHs SW8310 (mg/kg)											
Naphthalene	28	<0.024	<0.024	<0.027	<0.023	0.042	6.8	2	0.95	0.36	<0.025
TPH-Semivolatiles d/ SW8015M (mg/kg)											
Diesel Components	20000(JP-4)	5000(JP-4)	<11	<12	5100(JP-4)	11(JP-4)	3300(JP-4)	1800(JP-4)	1600(JP-4)	390(JP-5)	<12

TABLE 2.3 (Continued)  
SUMMARY OF DETECTED FUEL CONSTITUENTS IN SOIL SAMPLES  
POL SITE

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Analyte	SB-12	SB-13	SB-14	SB-15	SB-16	SB-17	SB-18	SB-19	SB-20	SB-21	SB-22
	3/12/94	3/21/94	3/21/94	3/21/94	3/24/94	3/24/94	3/24/94	3/24/94	3/24/94	3/24/94	3/26/94
	4-6'	4-6'	2-4'	4-6'	4-6'	2-4'	2-4'	2-4'	4-6'	2-4'	6-8'
	bgs	bgs	bgs	bgs	bgs	bgs	bgs	bgs	bgs	bgs	bgs
Aromatic Volatiles											
SW8020 (mg/kg)											
Benzene	1.1JD	.22JD c/	0.0073	<5JD	<0.013	ND a/	.0036J	0.00094	<0.025	ND	0.019
Toluene	10JD	1.5JD	0.025	51JD	0.082	ND	.0023J	ND	0.24	ND	0.1
Ethylbenzene	30JD	4.3JD	0.023	150JD	.56J b/	ND	.0019J	0.0057	0.34	ND	0.43
Xylenes	<0.5JD	<0.1JD	0.01	<5JD	0.11	ND	.009J	0.0015	<0.025	ND	0.071
PAHs SW8310											
(mg/kg)											
Naphthalene	3.8J	1.7	<0.024	9.8	0.039	<0.024	<0.024	<0.022	0.036	<0.024	<0.023
TPH-Semivolatiles d/											
SW8015M (mg/kg)											
Diesel Components	2900(JP-4)	750(JP-5)	<12	2800 J(JP-5)	290(JP-5)	<12	<12	<11	40(JP-4)	<12	<12

**TABLE 2.3 (Concluded)**  
**SUMMARY OF DETECTED FUEL CONSTITUENTS IN SOIL SAMPLES**  
**POL SITE**

**MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA**

Analyte	SO-01 e/ 3/10/94 4-6' bgs	SO-02 3/10/94 4-6' bgs	SO-03 3/12/94 4-6' bgs	SO-04 e/ 3/11/94 4-6' bgs	SO-05 3/21/94 4-6' bgs	SO-06 3/12/94 7-9' bgs	SO-07 3/13/94 8-10' bgs	SO-08 3/22/94 6-8' bgs	SO-09 3/22/94 6-8' bgs	SO-10 3/13/94 7-9' bgs	SO-11 3/26/94 10-12' bgs
<b>Aromatic Volatiles</b>											
SW8020 (mg/kg)											
Benzene	ND	0.0006	0.0022	.67JD c/	6.5JD	<13JD	ND a/	ND	ND	ND	ND
Toluene	ND	ND	ND	1.5JD	11JD	91JD	ND	ND	ND	ND	ND
Ethylbenzene	0.0011	ND	ND	7.7JD	48JD	240JD	ND	ND	0.0016	ND	ND
Xylenes	0.0015	0.0075	0.0017	1.7JD	33JD	<25JD	0.0032	0.0017	0.002	0.004	0.0029
<b>PAHs SW8310</b>											
(mg/kg)											
Naphthalene	<0.023	ND	<0.028	13J b/	7.2	4.6	0.05	<0.03	<0.027	<0.027	<0.028
<b>TPH-Semivolatiles d/</b>											
SW8015M (mg/kg)											
Diesel Components	<12	<12	<13	2900(JP-4)	7700(JP-4)	6800(JP-4)	<12	<15	<13	<13	<14

a/ ND - Not detected.

b/ J - Estimated quantitation based upon QC data.

c/ JD - Estimated quantitation based on dilution.

d/ TPH - Total petroleum hydrocarbons.

e/ SO - Soil borings that were converted to monitoring wells.



TABLE 2.4  
SUMMARY OF DETECTED FUEL CONSTITUENTS IN HAND-AUGERED SOIL SAMPLES  
POL SITE

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Analyte	HA-01	HA-02	HA-03	HA-04	HA-05	HA-06	HA-07	HA-08	HA-09
	3/15/94	3/15/94	3/21/94	3/21/94	3/21/94	3/21/94	3/21/94	3/15/94	3/15/94
	3-4'	5-6'	4-5'	4-5'	4-5'	5-6'	5-6'	4-5'	4-5'
	bgs	bgs	bgs	bgs	bgs	bgs	bgs	bgs	bgs
Aromatic Volatiles									
SW8020 (mg/kg)									
Benzene	ND a/	ND	<0.0025	0.00057	ND	<0.1	0.011	11JD	40JD
Toluene	ND	ND	<0.0025	0.0017	ND	.59JD d/	0.06J b/	19JD	69JD
Ethylbenzene	ND	ND	0.29	ND	ND	2.9JD	0.077	81JD	280JD
Xylenes	ND	0.0011	<0.025	0.0057	0.0072	.49JD	0.0062	55JD	210JD
PAHs SW8310									
(mg/kg)									
Naphthalene	<0.026	0.05	<0.024	<0.023	<0.024	0.71	<0.025	9.2	39
TPH-Semivolatiles c/									
SW8015M (mg/kg)	<13	<12	<12	<12	<12	310	<12	4100/5700 J	19000 J
Fuel Type						JP-5		JP-5/Gasoline	JP-4

TABLE 2.4 (Continued)  
SUMMARY OF DETECTED FUEL CONSTITUENTS IN HAND-AUGERED SOIL SAMPLES  
POL SITE

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Analyte	HA-10 3/15/94 4-5' bgs	HA-11 3/15/94 4-5' bgs	HA-12 3/15/94 5-6' bgs	HA-13 3/15/94 5-6' bgs	HA-14 3/15/94 4-5' bgs	HA-15 3/15/94 5-6' bgs	HA-16 3/15/94 5-6' bgs	HA-17 3/15/94 5-6' bgs	HA-18 3/14/94 4-5' bgs	HA-19 3/14/94 5-6' bgs
Aromatic Volatiles										
SW8020 (mg/kg)	<0.025	ND	<0.05	ND a/	ND	<2.5JD d/	1.8JD	.28JD	0.0011	<0.025J b/
Benzene	.52J	0.0014	1	0.00053	0.014	71JD	22JD	3.6JD	ND	.45J
Toluene	.75J	0.0017	2.1	ND	0.009	87JD	20JD	2.6JD	0.0013	1.8J
Ethylbenzene	0.097	0.0035	<0.05	ND	0.0035	<2.5JD	<0.25JD	<0.1JD	0.0095	<0.025J
Xylenes										
PAHs SW8310										
(mg/kg)										
Naphthalene	0.1	<0.024	<0.025	<0.024	<0.023	3.4	2.7	0.41	0.06	0.18
TPH-Semivolatiles c/										
SW8015M (mg/kg)	<23	<12	220	<12	<12	860	420	190	ND	640
Fuel Type			JP-4			JP-4	JP-5	JP-5		JP-4

**TABLE 2.4 (Concluded)**  
**SUMMARY OF DETECTED FUEL CONSTITUENTS IN HAND-AUGERED SOIL SAMPLES**  
**POL SITE**

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Analyte	HA-20 3/14/94 4-5' bgs	HA-21 3/14/94 5-6' bgs	HA-22 3/14/94 4-5' bgs	HA-23 3/14/94 5-6' bgs	HA-24 3/14/94 5-6' bgs	HA-25 3/14/94 5-6' bgs	HA-26 3/27/94 3-4' bgs	HA-27 3/27/94 3-4' bgs	HA-28 3/27/94 3-4' bgs	HA-29 3/27/94 1-2' bgs
Aromatic Volatiles										
SW8020 (mg/kg)										
Benzene	ND	0.28	.82JD	2.4JD	<0.1	<0.13JD d/	<0.0025	0.027	0.0058	<5JD
Toluene	ND	1.1	4.3JD	28JD	0.5	12JD	0.012	0.059	0.007	14JD
Ethylbenzene	ND	6.2JD	11JD	73JD	0.43	15JD	.06408J b/	0.24	0.011	48JD
Xylenes	.0025J	<0.05	<0.25JD	1.9JD	<0.1	<1.3JD	0.01642	0.053	0.027	<5JD
PAHs SW8310										
(mg/kg)										
Naphthalene	<0.025	0.77	7.1	5	0.094	4	.2J	0.025	0.036	13
TPH-Semivolatiles c/										
SW8015M (mg/kg)	<12	260	870	1800	<140	680	11	<12	<11	12000
Fuel Type		JP-4	JP-4	JP-4		JP-4	JP-4			JP-5

a/ ND - Not detected.  
b/ J - Estimated quantitation based upon QC data.  
c/ TPH - Total Petroleum Hydrocarbons.  
d/ JD - Estimated quantitation based on dilution.

1.18 and 1.29 feet, respectively. A summary of the laboratory analytical results for the ground water samples is presented in Table 2.5. The analytical methods were the same as those used for the soil samples.

MW-01 is located upgradient of the POL site and is designated as the background well for the site. MW-02 was originally installed as a second upgradient well to the northwest; however, ground water gradients indicate that MW-02 may lie downgradient from some portions of the POL site. Also, a ground water sample collected from well MW-02 contain a relatively high concentration of benzene. Figure 2.7 is a map of the site depicting monitoring well locations and total BTEX concentrations detected in ground water samples. The highest BTEX concentrations were detected at wells MW-06 and MW-11, with concentrations of 3,903 and 2,848  $\mu\text{g/L}$ , respectively. These wells are located downgradient from both the 1,050,000-gallon AST and the 1975 jet fuel spill.

The ground water BTEX results corresponded fairly well with the soil gas data and also with the soil and ground water screen data. The data indicate that the plume originates in the area of Building 522, the two USTs, and the area of the 1975 spill. The ground water flow direction from these locations is to the southwest and may possibly be discharging into the drainage ditch near monitoring wells MW-06 and MW-11. Monitoring well MW-44 is a deep well and does not appear to have been contaminated by the shallow ground water.

BTEX have not been detected in ground water samples from wells MW-08 and MW-09 on the south side of the drainage ditch. Based on the advective ground water velocity calculated from slug tests, there has been ample time for the plume to travel to monitoring wells MW-08 and MW-09, thus these data indicate that the drainage ditch may be intercepting shallow ground water that flows across the site.

#### **2.1.4.2 Surface Water and Sediment**

Five surface water and sediment samples were taken along the westward flowing drainage ditch on the southern border of the POL site in April 1994 (Law, 1994). These samples were analyzed for BTEX and PAHs. Samples taken upgradient of the POL site had detectable levels of both BTEX and PAHs in the sediment and surface water. These concentrations are attributed to the MOGAS site to the east and leakage from former USTs that were about 400 feet upstream. The sediment and water samples collected at the location of stressed vegetation and product sheen on the water surface, SW-03 and SD-03, had higher levels of BTEX and PAHs than the other four sample locations. The analytical data, therefore, suggest that hydrocarbons from the POL are being intercepted by the drainage ditch.

## **2.2 DEVELOPMENT OF CONCEPTUAL MODEL**

A conceptual model is a three-dimensional representation of the hydrogeologic system based on available geological, hydrological, climatological, and geochemical data. The purpose of developing a site conceptual model is to provide an understanding of the mechanism for contaminant fate and transport and to identify

**TABLE 2.5**  
**SUMMARY OF DETECTED FUEL CONSTITUENTS IN GROUND WATER SAMPLES**  
**POL SITE**

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Analyte	GW-01 4/5/94 (Bkgd)	GW-02 4/5/94	GW-03 4/7/94	GW-04 NA e/	GW-05 NA	GW-06 4/6/94	GW-07 4/6/94	GW-08 4/6/94	GW-09 4/6/94	GW-10 4/6/94	GW-11 4/6/94	GM33 4/5/94	GM34 4/5/94	GM35 4/5/94	GM36 4/5/94	GM44 4/5/94
<b>Aromatic Volatiles</b>																
SW8020 (ug/L)																
Benzene	ND a/	560	5.9	NS c/	NS	400	ND	ND	ND	ND	350	ND	ND	ND	ND	ND
Toluene	ND	ND	0.73	NS	NS	280	ND	ND	ND	ND	98	ND	ND	3.6	7.2	ND
Ethylbenzene	ND	ND	ND	NS	NS	3100	ND	ND	ND	1.8	2400	ND	ND	18J b/	140J	ND
Xylenes	ND	ND	ND	NS	NS	47	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<b>PAHs SW8310</b>																
(ug/L)																
Naphthalene	ND	14	<0.9	NS	NS	130	ND	ND	ND	0.7	ND	<0.7	<0.7	<0.7	22	<0.7
<b>TPH-Semivolatiles d/</b>																
SW8015M (mg/L)																
Diesel Components	<0.22	<0.22	<0.21	NS	NS	0.56	<0.23	<0.24	<0.24	<0.24	<0.21	<0.22	<0.22	<0.24	<0.21	<0.24

- a/ ND - Not detected.  
b/ J - Estimated quantitation based upon QC data.  
c/ NS - Not Sampled (free product).  
d/ TPH - Total Petroleum Hydrocarbons.

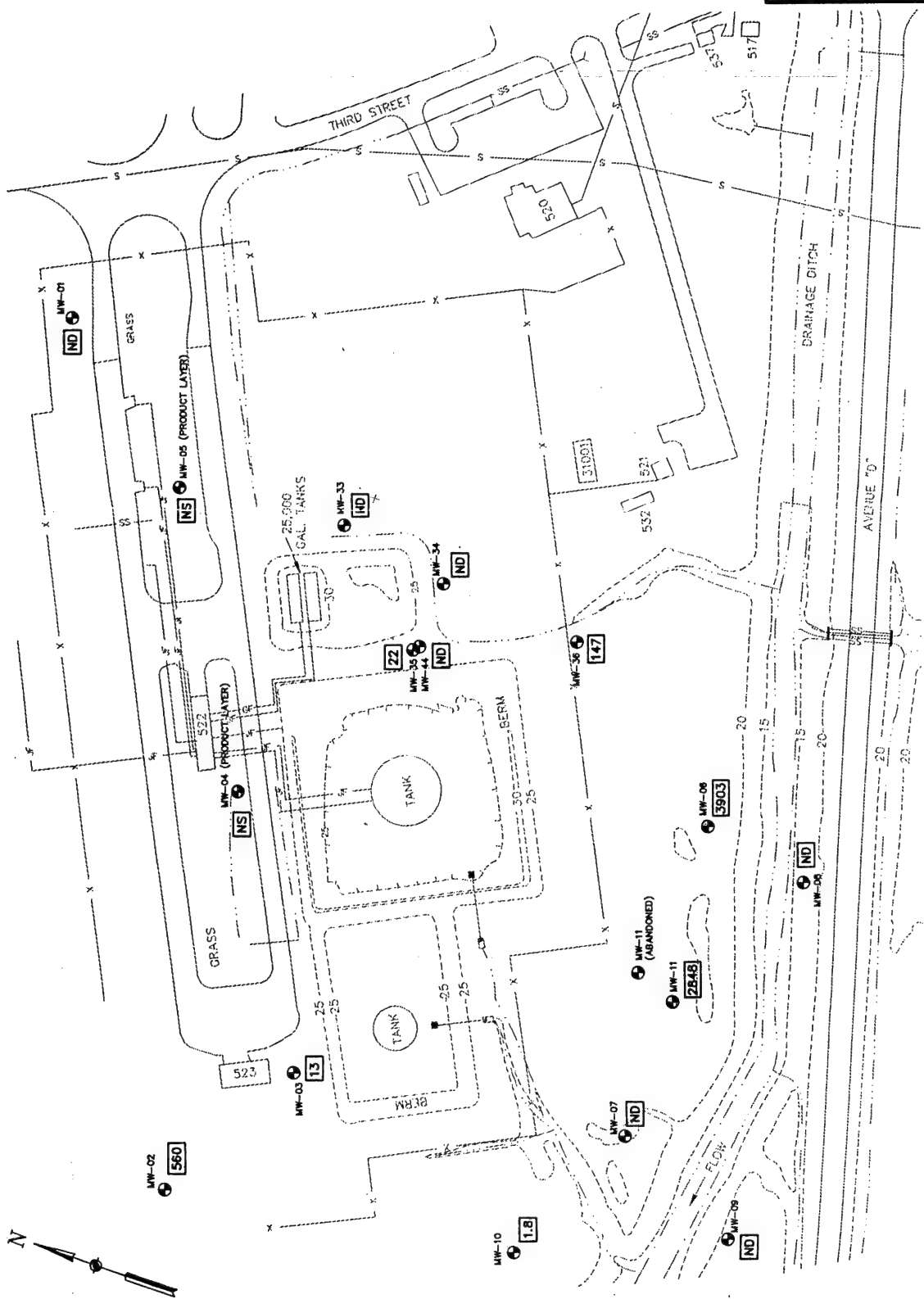


FIGURE 2.7  
TOTAL BTEX CONCENTRATIONS  
IN GROUND WATER (1994)  
POL SITE

Myrtle Beach Air Force Base  
South Carolina

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Denver, Colorado

additional data requirements. The model describes known and suspected sources of contamination, types of contamination, affected media, and contaminant migration pathways. The model provides a foundation for formulating decisions regarding additional data collection activities and potential remedial actions. The conceptual model for the POL site will be used to aid in selecting additional data collection points and to identify appropriate data needs for modeling hydrocarbon degradation using the Bioplume II model.

Successful conceptual model development involves:

- Defining the problem to be solved;
- Integrating available data, including
  - Local geologic and topographic data,
  - Hydraulic data,
  - Site stratigraphic data,
  - Contaminant concentration and distribution data;
- Evaluating contaminant fate and transport characteristics;
- Identifying contaminant migration pathways;
- Identifying potential receptors; and
- Determining additional data requirements.

### **2.2.1 Intrinsic Remediation and the Bioplume II Model**

After a site has been adequately characterized, fate and transport analyses can be performed to determine the potential for contaminant migration and whether any exposure pathway for human or ecological receptors is complete. The Bioplume II model has proved useful for predicting BTEX plume migration and contaminant attenuation by natural biodegradation. The Bioplume II model (Rifai *et al.*, 1988) can be used to evaluate critical ground water fate and transport processes that may be involved in some of the migration pathways to human and ecological receptors. Quantitative fate and transport analyses can be used to determine what level and extent of remediation is required.

An important consideration in determining whether fuel hydrocarbon contamination presents a substantial threat to human health and the environment and what type of remedial alternative will be most cost effective in eliminating or abating these threats is an accurate estimate of the potential for natural biodegradation of BTEX compounds in the ground water. Over the past two decades, numerous laboratory and field studies have demonstrated that subsurface microorganisms can degrade a variety of hydrocarbons (Lee *et al.*, 1988). This process occurs naturally when sufficient oxygen and nutrients are available in the ground water. The rate of natural biodegradation is generally limited by the lack of oxygen rather than by the lack of nutrients such as nitrogen or phosphorus. The supply of oxygen to unsaturated soil is constantly renewed by the vertical diffusion from the atmosphere. The supply of oxygen to a

shallow, fuel-contaminated aquifer is constantly renewed by the influx of oxygenated, upgradient flow and the vertical diffusion of oxygen from the unsaturated soil zone into the ground water (Borden and Bedient, 1986). The rate of natural biodegradation in unsaturated soil and shallow aquifers is largely dependent upon the rate at which oxygen enters the contaminated media.

### 2.2.2 Biodegradation of Dissolved BTEX Contamination

The Bioplume II model is a well-documented and widely accepted numerical model available for modeling the fate and transport of fuel hydrocarbons under the influence of advection, dispersion, sorption, and natural aerobic and anaerobic biodegradation. The positive effect of these processes on reducing the actual mass of fuel-related contamination dissolved in ground water has been termed intrinsic remediation. The advantages of intrinsic remediation include: (1) contaminants are transformed to innocuous byproducts (e.g., carbon dioxide and water), not just transferred to another phase or location within the environment; (2) current pump-and-treat technologies are energy intensive and generally not as effective in reducing residual contamination; (3) the process is nonintrusive and allows continuing use of infrastructure during remediation; (4) current engineered remedial technologies may pose a greater risk to potential receptors than intrinsic remediation because contaminants may be transferred into the atmosphere during remediation activities; and (5) intrinsic remediation is far less costly than conventional, engineered remedial technologies.

To estimate the impact of natural attenuation on the fate and transport of BTEX compounds dissolved in ground water at a site, two important lines of evidence must be demonstrated (Wiedemeier *et al.*, in preparation). The first is a documented loss of contaminants at the field scale. Dissolved concentrations of biologically-recalcitrant tracers found in most fuel contamination are used in conjunction with aquifer hydrogeologic parameters such as ground water seepage velocity and dilution to demonstrate that a reduction in the total contaminant mass is occurring at the site. The second line of evidence involves the use of chemical analytical data in mass balance calculations to show that areas with BTEX contamination can be correlated to areas with depleted electron acceptor (e.g., oxygen, nitrate, and sulfate) concentrations and increases in metabolic fuel degradation byproduct concentrations (e.g., methane and ferrous iron). With this site-specific information, the Bioplume II computer model can be used to simulate the fate and transport of dissolved BTEX compounds under the influence of the process of natural attenuation.

The Bioplume II model is based upon the US Geological Survey (USGS) two-dimensional (2-D) solute transport model, which has been modified to include a biodegradation component that is activated by a superimposed plume of dissolved oxygen. Bioplume II solves the USGS 2-D solute equation twice, once for hydrocarbon concentrations in the ground water and once for a dissolved oxygen plume. The two plumes are then combined using superimposition at every particle move to simulate biological reactions between fuel products and oxygen. If appropriate, biodegradation of contaminants by anaerobic processes is simulated using a first-order anaerobic decay rate.



### 2.2.3 Initial Conceptual Model

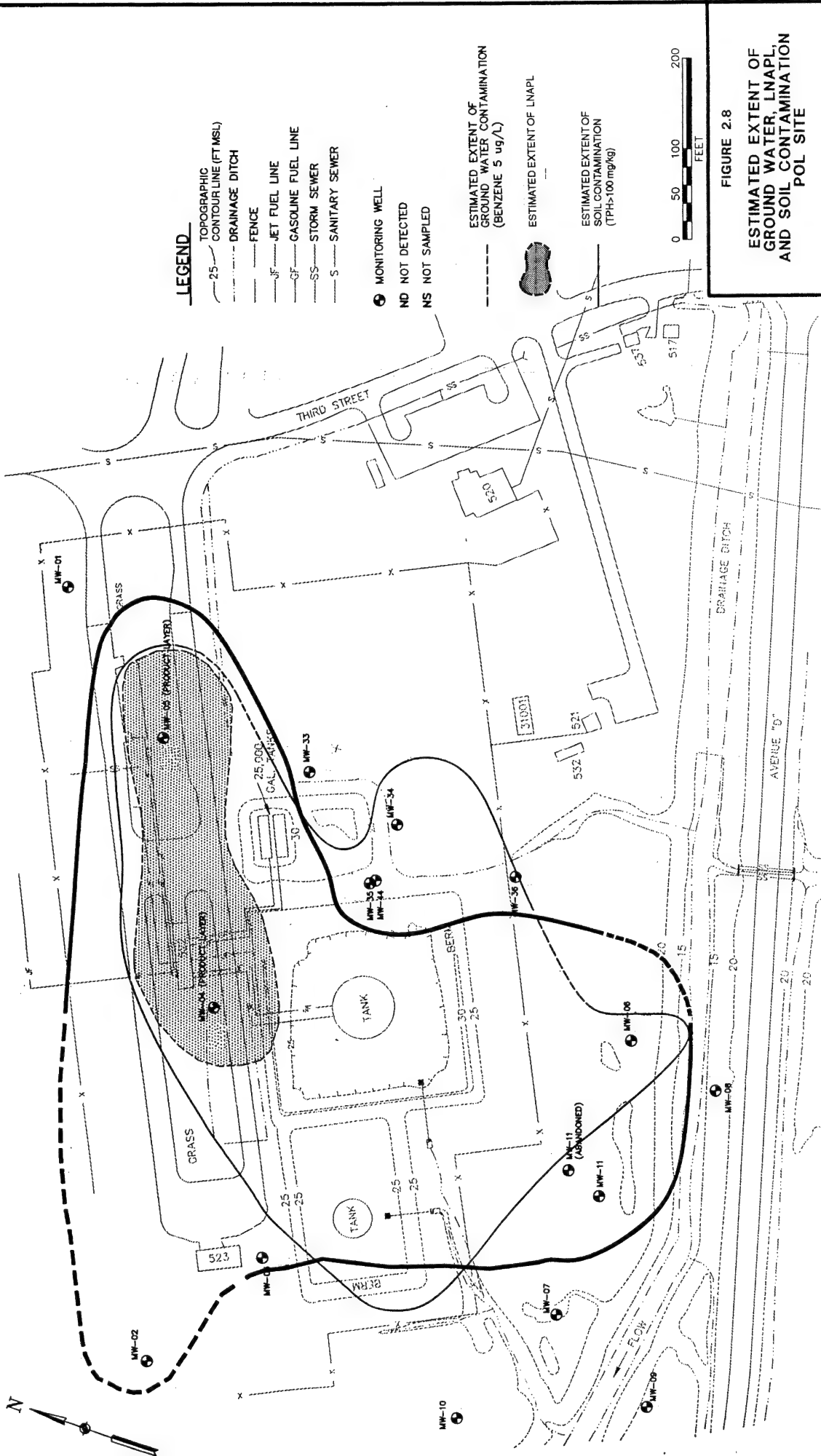
Site hydrogeologic data were previously integrated to produce hydrogeologic cross-sections of the site (Law, 1994). Cross-sections A - A' and B - B' (Figures 2.3 and 2.4) show the dominant hydrostratigraphic units present at the site and the position of the water table. Figure 2.5 is a ground water surface map prepared using April 1994 ground water elevation data (Law, 1994).

Ground water occurs in the sands and interbedded clays in the vicinity of the POL site, and flows to the south and west toward the drainage ditch bordering the site. The drainage ditch discharges into the Intracoastal Waterway north of the Base. Based on available data, Parsons ES will model the site as an unconfined, fine- to coarse-grained sand with interbedded clay aquifer. This conceptual model will be modified as necessary as additional site hydrogeologic data become available.

LNAPL is present at the POL site; therefore, it may be necessary to use the fuel/water partitioning models of Bruce *et al.* (1991) or Cline *et al.* (1991) to provide a conservative source term to model the partitioning of BTEX compounds from the free-product phase into the ground water. In order to use one of these models, samples of free product will be collected and analyzed for mass fraction of BTEX compounds. As an alternative, Parsons ES will attempt to collect ground water samples from immediately below the LNAPL, if possible. Figure 2.8 shows the location of the LNAPL, and the extent of both the soil and ground water contamination. This map will be used for assessing the location of new monitoring wells to define the LNAPL extent and the dissolved BTEX plume.

The chemicals of concern for ground water or surface water at or migrating from the POL site include the BTEX compounds, naphthalene, and diesel fuel constituents. The BTEX compounds will be the primary focus of this intrinsic remediation study because of their regulatory importance. The Bioplume II model will simulate the degradation of BTEX at the POL site and will be used to predict the concentration and extent of the contaminant plume in the ground water over time.

The chemicals of concern for the POL site are expected to partition from contaminated unsaturated soil, which contains fuel residuals, or from mobile LNAPL floating on the ground water surface into the underlying ground water, and migrate downgradient as a dissolved contaminant plume. In addition to the effects of mass transport mechanisms (volatilization, dispersion, diffusion, and adsorption), these dissolved contaminants will likely be removed from the ground water system by naturally occurring destructive attenuation mechanisms, such as biodegradation. The effects of these fate and transport processes on the dissolved ground water plume will be investigated using the quantitative ground water analytical data and the solute-transport model, Bioplume II. Data collection and analysis requirements are discussed in Section 3 of this work plan.



# **LEGEND**

- TOPOGRAPHIC CONTOUR LINE (FT MSL)
- 25 DRAINAGE DITCH
- FENCE
- JET FUEL LINE
- GASOLINE FUEL LINE
- STORM SEWER
- SANITARY SEWER
- MONITORING WELL
- ND NOT DETECTED
- NS NOT SAMPLED

ESTIMATED EXTENT OF GROUND WATER CONTAMINATION (BENZENE 5 ug/L)

ESTIMATED EXTENT OF LNAPL

ESTIMATED EXTENT OF SOIL CONTAMINATION (TPHs-100 mg/kg)



**FIGURE 2.8**

## **ESTIMATED EXTENT OF GROUND WATER, LNAPL, AND SOIL CONTAMINATION POL SITE**

Myrtle Beach Air Force Base  
South Carolina

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Denver, Colorado

#### 2.2.4 Potential Pathways and Receptors

Potential preferential contaminant migration pathways such as ground water discharge points and subsurface utility corridors (artificial conduits) will be identified during the field work phase of this project. The primary potential migration path for contaminants at the site is from the remaining contaminated soils at the site to the ground water and from the ground water to potential receptors via consumption or other use. Shallow ground water beneath the POL site flows toward the drainage ditch to the south and southwest of the site, and the drainage discharges into the Intracoastal Waterway north of the Base. Surface drainage from the site is to the north, both by overland flow and *via* the drainage ditch located onsite. Because the site is secure and isolated in a low-use area of the Base, flora and fauna are the probable receptors of any soil, surface water, or sediment contamination.

The potential for exposure to contaminated water originating from the site through drinking water supplies is low because the Base is a restricted area and the drinking water does not come from wells located near the POL site. There are residential areas near the Base and several trailer parks, but their water is supplied from the city water system. Some residents still get their water from wells in the shallow unconfined aquifer, but these areas are located at least 1 mile downgradient from the POL site.

## SECTION 3

### COLLECTION OF ADDITIONAL DATA

To complete the CAP and to evaluate whether natural attenuation of fuel-related contaminants is occurring, additional site-specific hydrogeologic data will be collected. The physical and chemical hydrogeologic parameters listed below will be determined during the field work phase of the CAP.

Physical hydrogeologic characteristics include:

- Depth from measurement datum to the ground water surface in existing monitoring wells;
- Locations of potential ground water recharge and discharge areas;
- Locations of downgradient wells and their uses;
- Hydraulic conductivity through slug tests, as required;
- Estimation of dispersivity, where possible;
- Stratigraphic analysis of subsurface media;
- Ground water temperature; and
- Determination of extent and thickness of free- and residual-phase product.

Chemical hydrogeologic characteristics include:

- Dissolved oxygen (DO) concentration;
- Specific conductance;
- pH;
- Chemical analysis of free product to determine mass fraction of BTEX; and
- Additional chemical analysis of ground water and soil for the parameters listed in Table 3.1.

Field work described in this work plan in support of the CAP will be completed in January 1995. The objective of field work will be to define the extent of residual and free-phase hydrocarbon contamination using CPT in conjunction with laser induced fluorescence LIF testing and limited soil sampling. Residual and free-phase hydrocarbon contamination was sampled during field operations conducted in 1994; however,

**TABLE 3.1**  
**ANALYTICAL PROTOCOL FOR**  
**GROUND WATER AND SOIL SAMPLES**

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

MATRIX	METHOD	FIELD (F) OR ANALYTICAL LABORATORY (L)
<b>WATER</b>		
Total Iron	Colorimetric, HACH Method 8008 (or similar)	F
Ferrous Iron (Fe+2)	Colorimetric, HACH Method 8146 (or similar)	F
Ferric Iron (Fe+3)	Difference between total and ferrous iron	F
Manganese	Colorimetric, HACH Method 8034 (or similar)	F
Sulfide	Colorimetric, HACH Method 8131 (or similar)	F
Sulfate	Colorimetric, HACH Method 8051 (or similar)	F
Nitrate	Titrimetric, HACH Method 8039 (or similar)	F
Nitrite	Titrimetric, HACH Method 8507 (or similar)	F
Redox Potential	A2580B, direct reading meter	F
Oxygen	Direct reading meter	F
pH	E150.1/SW9040, direct reading meter	F
Conductivity	E120.1/SW9050, direct reading meter	F
Temperature	E170.1	F
Alkalinity (Carbonate [CO3-2] and Bicarbonate [HCO3-1])	Titrimetric, HACH Method 8221 (or similar)	F
Nitrate	E300 or SW9056	L
Nitrite	E300 or SW9056	L
Chloride	E300 or SW9056	L
Sulfate	E300 or SW9056	L
Alkalinity	E150.1	L
Methane	RSKSOP147	L
Total Organic Carbon	A5310C (RSKSOP-102)	L
Aromatic Hydrocarbons (Including Trimethylbenzene and Tetramethylbenzene)	SW8020 (RSKSOP-133)	L
Total Hydrocarbons	SW8015, modified	L
Free Product	GS/MSD fuel identification	L
Ammonia--Diss. Gas in Water	RSKSOP	L
<b>SOIL</b>		
Total Organic Carbon	SW9060	L
Moisture	ASTM D-2216	L
Aromatic Hydrocarbons	SW8020	L
Total Hydrocarbons	SW8015, modified	L

additional LIF testing will be required during the upcoming field operations to define the extent of residual and mobile LNAPL. These activities will also include ground water monitoring point installation; CPT testing; and ground water, free product, and soil sampling.

The following sections describe the procedures that will be followed when performing field investigations and collecting site-specific data. The CPT/LIF system is described in Section 3.1. Procedures for soil sample collection to verify CPT/LIF data are described in Section 3.1.2. Procedures for the installation of new monitoring points are described in Section 3.2. Procedures for sampling existing ground water monitoring wells and newly installed ground water monitoring points are described in Section 3.3. Sample handling procedures are described in Section 3.4, and procedures for the measurement of aquifer parameters (e.g., hydraulic conductivity) are described in Section 3.5.

### **3.1 CONE PENETROMETRY**

Subsurface conditions at the site will be characterized using CPT coupled with LIF. Cone penetrometry is an expeditious and effective means of analyzing the stratigraphy of a site by measuring the resistance against the conical probe of the penetrometer as it is pushed into the subsurface. Stratigraphy is determined from a correlation of the point stress at the probe tip and frictional stress on the side of the cone. Soil samples are collected to correlate the CPT readings to the lithologies present at the site.

CPT will be conducted using the US Army Corps of Engineers' (USACE's) cone penetrometer truck. This equipment consists of an instrument probe that is forced into the ground using a hydraulic load frame mounted on a heavy truck, with the weight of the truck providing the necessary reaction mass. The penetrometer equipment is housed in a stainless steel, dual-compartment body mounted on a 43,000-pound, triple-axle Kenworth® truck chassis powered by a turbo-charged diesel engine. The weight of the truck and equipment is used as ballast to achieve the overall push capability of 39,000 pounds. This push capacity may be limited in tight soils by the structural bending capacity of the 1.40-inch outside-diameter (OD) push rods, rather than by the weight of the truck. The current 39,000-pound limitation is intended to minimize the possibility of push-rod buckling. Penetration force is supplied by a pair of large hydraulic cylinders bolted to the truck frame.

The penetrometer probe is of standard dimensions, having a 1.40-inch OD, a 60-degree conical point with sacrificial tip, and an 8.0-inch-long by 1.40-inch OD friction sleeve. Inside the probe, two load cells independently measure the vertical resistance against the conical tip and the side friction along the sleeve. Each load cell is a cylinder of uniform cross-section which is instrumented with four strain gauges in a full-bridge circuit. Forces are sensed by the load cells, and the data are transmitted from the probe assembly via a cable running through the push tubes. The analog data are digitized, recorded, and plotted by computer in the penetrometry truck. A grout tube also runs down the push cylinder to allow the introduction of cement grout to the hole in order to seal the CPT hole. The USACE CPT is not equipped to monitor pore pressure; therefore, the location of the water table will not be measured using the CPT apparatus. Evaluation of point and sleeve stresses can often provide an estimated depth to ground water. The

penetrometer is usually advanced vertically into the soil at a constant rate of 2 cm/s, although this rate must sometimes be reduced, such as when hard layers are encountered. Penetration, dissipation, and resistivity data will be used to determine potential site layering as it is encountered in the field.

The known propensity of aromatic hydrocarbons to fluoresce under ultraviolet wavelengths has allowed the use of LIF technology, in conjunction with CPT technology, to detect soil characteristics and hydrocarbon contamination simultaneously. The LIF is not capable of detecting chlorinated solvents. The LIF is only useful for more grossly contaminated areas with free phase or high residual contamination. The lower range of detection is greater than 100 ppm total hydrocarbon. The LIF system has a 0.25-inch sapphire window in the side of the cone that allows a laser to scan the soil for fluorescent compounds as the LIF penetrometer rod pushes through soil. Assuming that aromatic hydrocarbons are simultaneously solvenated with other fuel-hydrocarbon constituents, the magnitude of aromatic fluorescence is indicative of hydrocarbon contamination in a soil matrix. Fiber optic cables connected to the laser spectrometer and a 6-pair electrical conductor connected to the CPT data acquisition system, are routed through the interior of the push tubes to the CPT probe.

The basic components of the LIF instrument are a nitrogen laser, a fiber optic probe, a monochromator for wavelength resolution of the return fluorescence, a photomultiplier tube to convert photons into an electrical signal, a digital oscilloscope for waveform capture, and a control computer. The fiber optic probe for the cone penetrometer consists of delivery and collection optical fibers, a protective sheath, a fiber optic mount within the cone, and a 0.25-inch sapphire window (Figure 3.1).

The results of each LIF/CPT push will be available 2 or 3 minutes after the completion of each hole. Graphs showing cone resistance, sleeve friction, soil classification, fluorescence intensity, and wavelength will be plotted by USACE personnel at the conclusion of each penetration and presented to the Parsons ES field scientist in order to allow investigative decisions to be based on the most current information.

### 3.1.1 CPT/LIF Testing Strategy

The purpose of the LIF/CPT testing at the site is to determine subsurface stratigraphy and to better define the areal and vertical extent of residual fuel hydrocarbons in the unsaturated zone and free-phase hydrocarbons in the site ground water. The CPT will be pushed from ground surface to below fluorescing contamination, refusal, or up to 60 feet bgs, depending on contaminant distribution and subsurface conditions. In order to define the edges of LNAPL contamination, CPT/LIF points will be placed at the locations shown on Figure 3.2. The majority of the points will be used to define the LNAPL layer that was discovered in monitoring wells MW-04 and MW-05. Points will be placed at the estimated outer extent of the LNAPL, and between the two monitoring wells to establish whether the product layer is continuous. CPT/LIF points will also be placed closer or further away as necessary to define the extent of the layer. Other CPT/LIF sites are located downgradient of the two USTs in the approximate location of the 1975 fuel line rupture, and one CPT/LIF point will be located north of the 420,000-gallon AST berm.



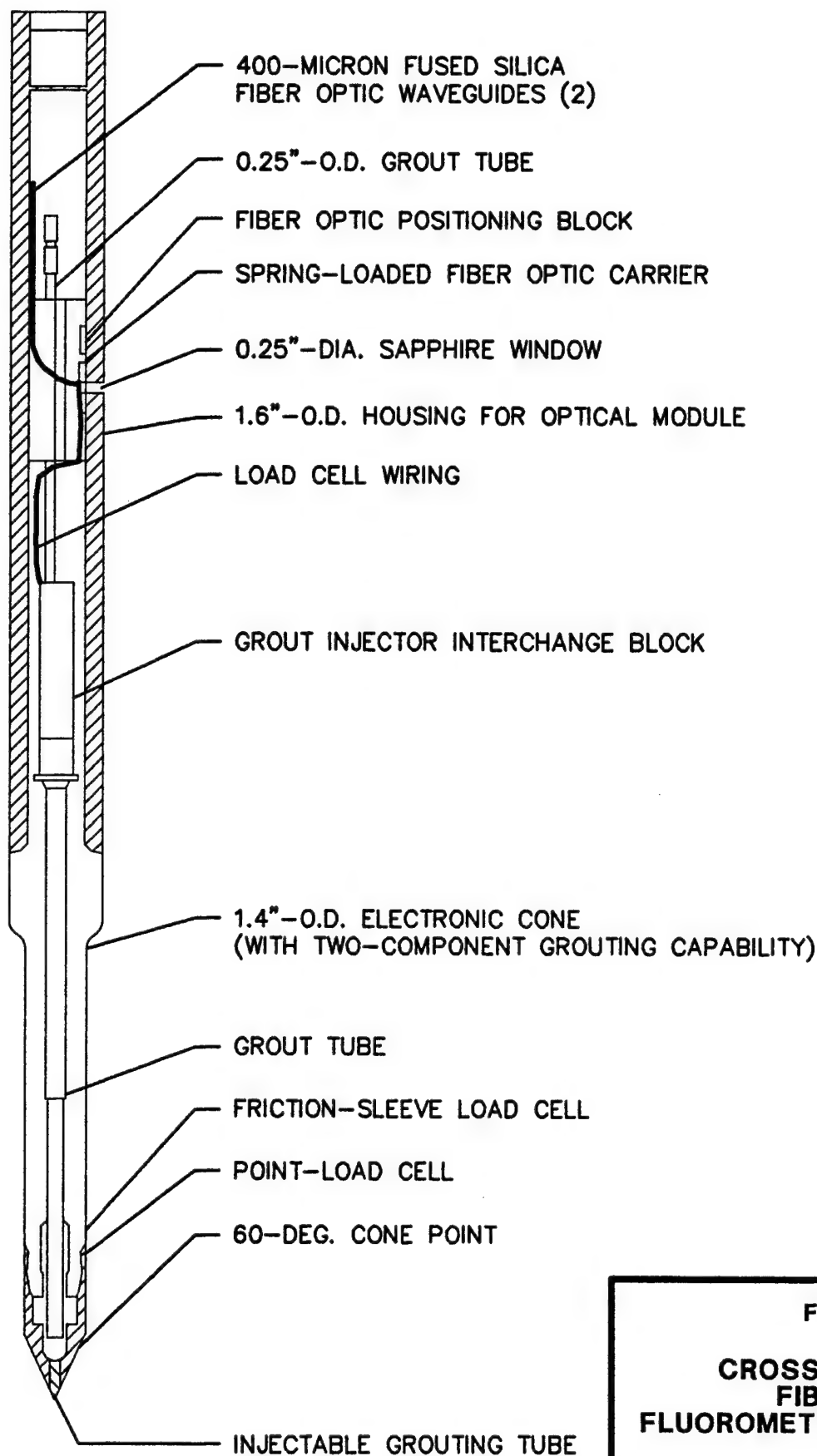


FIGURE 3.1

**CROSS SECTION OF  
FIBER OPTIC  
FLUOROMETRY PENETROMETER**

Myrtle Beach Air Force Base  
South Carolina



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# LEGEND

- 25 — CONTOUR LINE
- DRAINAGE DITCH
- FENCE
- JF — JET FUEL LINE
- GF — GASOLINE FUEL LINE
- SS — STORM SEWER
- S — SANITARY SEWER
- ISOPLETH CONTOUR (BENZENE IN GROUND WATER (µg/l))

- MONITORING WELL
- ▲ PROPOSED SHALLOW SOIL SAMPLE LOCATION
- ND NOT DETECTED
- ND NOT DETECTED
- PROPOSED CPT/LIF LOCATION
- ➔ APPROXIMATE DIRECTION OF GROUND WATER FLOW
- 560 BENZENE CONCENTRATION, APRIL 1994 (µg/l)
- ELEVATIONS REPORTED IN FT-MSL

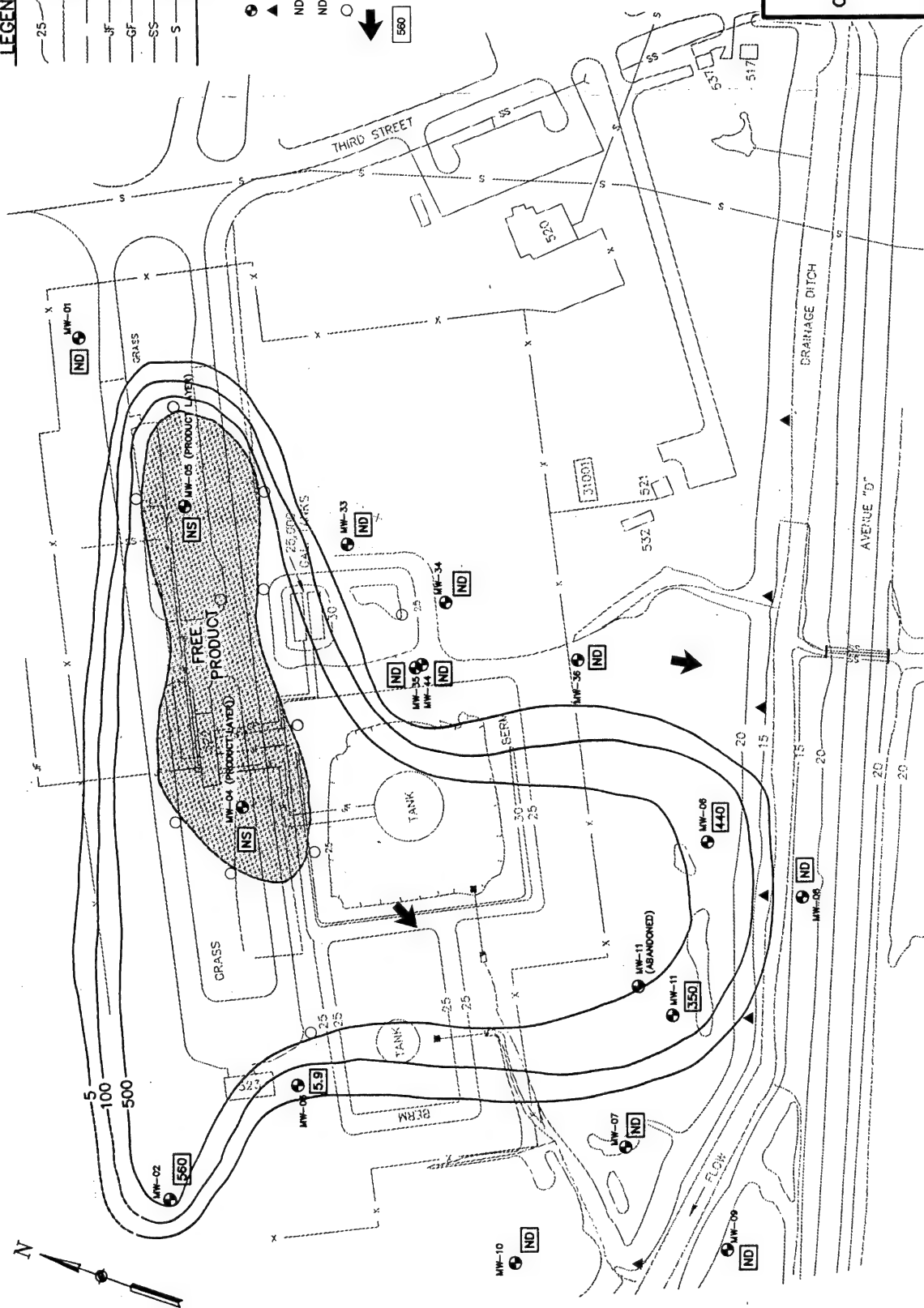


FIGURE 3.2

## PROPOSED CPT/LIF SAMPLING LOCATIONS POL SITE

Myrtle Beach Air Force Base  
South Carolina

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Base personnel will be responsible for identifying the location of all utility lines, USTs, fuel lines, and any other underground infrastructure prior to any CPT activities. All necessary digging permits will be obtained by Base personnel prior to mobilizing to the field. Base personnel will also be responsible for acquiring drilling and monitoring point installation permits for the proposed CPT/LIF locations indicated in Figure 3.2.

### 3.1.2 Soil Sampling and Analysis

To check the CPT soil classifications and to calibrate the LIF data, soil samples from discrete intervals will be collected at the site. Soil samples will be collected from varied soil matrices (if present) from within source areas and visually contaminated areas, at the fringe of the identified residual or LNAPL hydrocarbon plume, and outside of the LNAPL plume. In addition, approximately six samples will be collected along the edge of the drainage ditch at a depth of approximately 1 foot.

When soil samples are collected using the CPT, a Hoggen-Toggler<sup>®</sup> attachment for the CPT push rods will be used. A Hoggen-Toggler<sup>®</sup> sampler is a device used to collect undisturbed soil samples at any desired depth within the range of the driving apparatus. The sampler is coupled to the penetrometer rod and pushed into the soil with the CPT truck. With the Hoggen-Toggler<sup>®</sup> cone in the closed position, soil is prevented from entering the sampling tube until the desired depth is achieved. When the sampler has been pushed to the depth at which the soil sample is to be taken, the sampling unit is raised a few inches and the Hoggen-Toggler<sup>®</sup> apparatus is opened. The open Hoggen-Toggler<sup>®</sup> is pushed to fill with soil, then pulled from the ground as quickly as possible. The Hoggen-Toggler<sup>®</sup> sampling apparatus allows collection of 8-inch-long by 1-inch inside-diameter (ID) continuous samples. Recovery efficiencies for samples in saturated or sandy soils are often reduced, or the samples are compromised, because of spillage of the soil from the device after extraction. To mitigate this problem, soil samples will be compressed *in situ* with the penetrometer and Hoggen-Toggler<sup>®</sup> assembly to expel the pore water before extraction.

When the Hoggen-Toggler<sup>®</sup> sampling technique described above is ineffective or unable to efficiently provide sufficient soil volumes for the characterization of the site, soil samples will be obtained using a hand auger or similar method judged acceptable by the Parsons ES field scientist. Procedures will be modified, if necessary, to ensure good sample recovery.

Recovered soil will be placed in analyte-appropriate sample containers (Appendix A) and shipped to the analytical laboratory for analysis of BTEX, total organic carbon (TOC), moisture content, and total petroleum hydrocarbons (TPH) by the analytical methods listed in Table 3.1. The lithology of recovered soil will be recorded for comparison and correlation with CPT results.

The Parsons ES field scientist will be responsible for observing all field investigation activities, maintaining a detailed descriptive log of all subsurface materials recovered during soil coring, photographing representative samples, and properly labeling and storing samples. An example of the proposed geologic boring log form is presented in Figure 3.3. The descriptive log will contain the following information:

# GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: \_\_\_\_\_ CONTRACTOR: \_\_\_\_\_ DATE SPUD: \_\_\_\_\_  
 CLIENT: AFCEE RIG TYPE: \_\_\_\_\_ DATE CMPL.: \_\_\_\_\_  
 JOB NO.: 722450.22 DRLG METHOD: \_\_\_\_\_ ELEVATION: \_\_\_\_\_  
 LOCATION: MYRTLE BEACH AFB BORING DIA.: \_\_\_\_\_ TEMP: \_\_\_\_\_  
 GEOLOGIST: \_\_\_\_\_ DRLG FLUID: \_\_\_\_\_ WEATHER: \_\_\_\_\_  
 COMENTS: \_\_\_\_\_

Elev (ft)	Depth (ft)	Pro- file	US CS	Geologic Description	Sample		Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
					No.	Depth (ft)					
	1										
	5										
	10										
	15										
	20										
	25										
	30										
	35										

## NOTES

bgs - Below Ground Surface  
 GS - Ground Surface  
 TOC - Top of Casing  
 NS - Not Sampled  
 SAA - Same As Above

## SAMPLE TYPE

D - DRIVE  
 C - CORE  
 G - GRAB


 Water level drilled

FIGURE 3.3

## GEOLOGIC BORING LOG

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- Sample interval (top and bottom depth);
- Sample recovery;
- Presence or absence of contamination based on visual observations, odor, and photoionization detector (PID) headspace VOC measurements;
- Lithologic description, including relative density, color, major textural constituents, minor constituents, porosity, relative moisture content, plasticity of fines, cohesiveness, grain size, structure or stratification, relative permeability, and any other significant observations; and
- Depths of lithologic contacts and/or significant textural changes measured and recorded to the nearest 0.1 foot.

### **3.1.3 CPT Locations and Datum Survey**

The horizontal location of all CPT/LIF testing locations relative to established Base coordinates will be measured by a surveyor. Horizontal coordinates will be measured to the nearest 0.1 foot. The elevation of the ground surface will also be measured to the nearest 0.1 foot relative to a USGS msl datum. Sample location and other relevant site information for the soil cores collected for verification purposes will be recorded by the Parsons ES field scientist.

### **3.1.4 Site Restoration**

After sampling is complete, each CPT site will be restored as closely to its original condition as possible. Any test holes remaining open after extraction of the penetrometer rod will be sealed with hydrated bentonite chips, pellets, or grout to eliminate the creation or enhancement of contaminant migration pathways to the ground water.

### **3.1.5 Equipment Decontamination Procedures**

The CPT push rods will be cleaned with potable water using the USACE CPT steam-cleaning system (rod cleaner) as the rods are withdrawn from the ground. A vacuum system located beneath the CPT truck will be used to recover rinseate. Use of this system results in nearly 100-percent recovery of steam-cleaning rinseate from the rod cleaner. Rinseate is generated only as the rods move past the cleaner, thereby minimizing liquid waste generation. Care will be taken not to apply the pressurized steam to the LIF module, which will be decontaminated by hand. Rinseate will be collected in 55-gallon drums. Filled 55-gallon drums will be stored at the Base, and Base personnel will arrange for final disposal of the drums and their contents. Base personnel are responsible for sampling the contents of the drums to identify any hazardous constituents before the drums are transported to an appropriate disposal facility.

Other downhole and sampling equipment will be decontaminated by steam cleaning or by the procedures specified in Section 3.3.2.1.

Potable water to be used in CPT equipment cleaning, decontamination, or grouting will be obtained from one of the Base water supplies. Water use approval will be verified

by contacting the appropriate facility personnel. The field scientist will make the final determination as to the suitability of site water for these activities. Precautions will be taken to minimize any impact on the surrounding area that might result from decontamination operations.

### **3.2 PERMANENT MONITORING POINT INSTALLATION**

To further characterize the hydrogeologic conditions of the shallow subsurface, up to 28 ground water monitoring points may be installed at the POL site to supplement the existing site monitoring wells. The following sections describe the proposed monitoring point locations and completion intervals, monitoring point installation, monitoring point development, and equipment decontamination procedures.

#### **3.2.1 Monitoring Point Locations and Completion Intervals**

The locations of 28 proposed ground water monitoring points are identified for the POL site on Figure 3.4. The proposed locations for the new monitoring points were determined from a review of existing data gathered during previous site activities. Monitoring point locations were selected to provide hydrogeologic data necessary for successful implementation of the Bioplume II model and to monitor potential fuel hydrocarbon migration from the site. Monitoring point locations were selected to define three aspects of the POL site: 1) the areal extent of contamination, 2) the horizontal and vertical distribution of dissolved BTEX, and 3) the hydrogeology and ground water flow direction at the site. The proposed locations shown on Figure 3.4 may be modified in the field as a result of encountered field conditions and acquired field data.

Several shallow monitoring points are proposed to define the areal extent of contamination. Three shallow monitoring points will be located along the upgradient edge of the POL site to better define the suspected source area and to investigate potential contaminants migrating into the POL site. An additional twelve shallow monitoring points are proposed to be located within and along the east, south, and west borders of the estimated dissolved BTEX plume to define the lateral extent of the contaminant migration. Of these twelve, two points will be located in the drainage ditch southwest of the site near the oil/water separator. Drains from the bermed areas surrounding both of the existing ASTs discharge to this ditch. Another of the twelve points will be placed in a cluster with the existing well MW-06 to evaluate contamination in the top few feet of ground water.

The drainage ditch appears to serve as a discharge point for shallow ground water from both the north and south sides of the ditch; however, regional ground water flow is expected to be relatively unaffected by the drainage ditch. For this reason, three deep monitoring points will be located south of the drainage ditch, to investigate the possibility that the contaminant plume may be extending vertically downward into the aquifer and migrating beneath the drainage ditch. As the influence of the drainage ditch is thought to be local, the two deep monitoring points located south of Avenue "D" are expected to be far enough away from the drainage ditch that they will not be influenced by the ditch and will indicate the true regional flow direction and gradient.

# LEGEND

- 25 — CONTOUR LINE
- DRAINAGE DITCH
- FENCE
- JF — JET FUEL LINE
- GF — GASOLINE FUEL LINE
- SS — STORM SEWER
- S — SANITARY SEWER
- ISOPLETH CONTOUR

● MONITORING WELL

ND NOT DETECTED

ND NOT DETECTED

⊙ PROPOSED MONITORING POINT

→ APPROXIMATE DIRECTION OF GROUND WATER FLOW

◆ PROPOSED LOCATION OF 6 TEMPORARY GEOPROBE MONITORING POINTS

560 BENZENE CONCENTRATION, APRIL 1994 (μg/l)

ELEVATIONS REPORTED IN FT-MSL

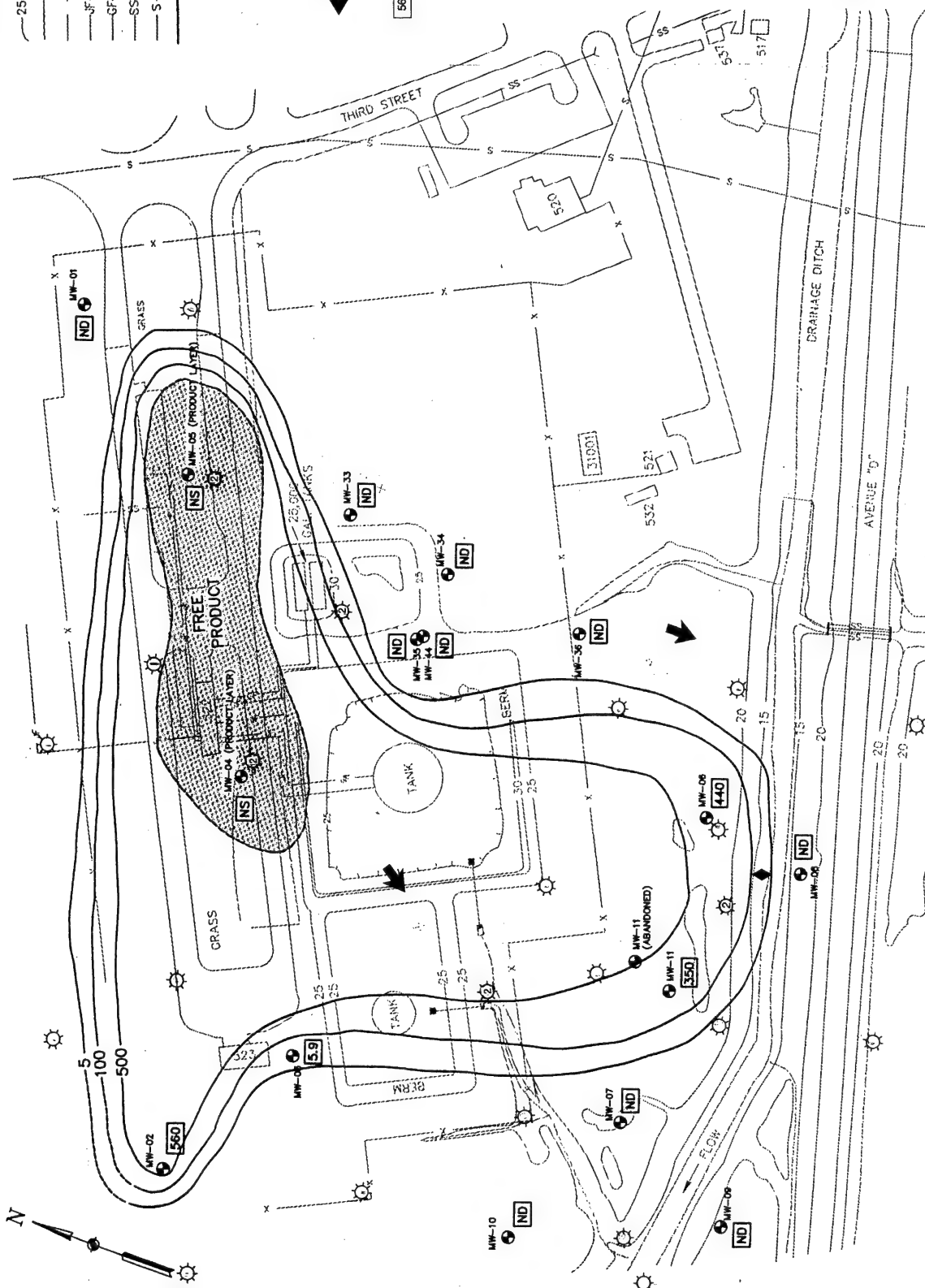


FIGURE 3.4

## PROPOSED MONITORING POINT LOCATIONS POL SITE

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Performance of CPT at the three points south of the drainage ditch also will assist in evaluation of the lithology and stratigraphy south of the POL site.

At five additional locations, clusters of two monitoring points are proposed to define the extent of the dissolved plume both horizontally and vertically. At the three locations where a monitoring well is not present, monitoring point clusters will consist of a shallow point screened across the shallow aquifer at or near the water table, and a deep point screened to sample ground water lower in the aquifer. Because existing wells MW-04 and MW-05 intersect the water table and contain LNAPLs, both monitoring points in each of these clusters will be screened below the water table in order to evaluate the vertical extent of ground water contamination.

Screened intervals for shallow monitoring points will extend from approximately 1 foot above the water table to 2 feet below the water table. Deep points will be placed on the basis of lithology, or approximately 10 feet below the next shallowest monitoring point (in the absence of significant lithologic changes). All monitoring points will be installed with 1 meter of screen. The proposed screened intervals of 1 meter will help mitigate the dilution of water samples from potential vertical mixing of contaminated and uncontaminated ground water in the monitoring point casing, and will give important information on the nature of vertical hydraulic gradients in the area. Adjustments of the depth and length of the screened interval of the monitoring points may be necessary in response to actual aquifer conditions and contaminant stratification identified during LIF/CPT testing.

### **3.2.2 Monitoring Point Installation Procedures**

This section describes the procedures to be used for installation of new ground water monitoring points. All new monitoring points will be constructed of 0.75-inch OD/0.5-inch ID polyvinyl chloride (PVC) casing placed with a CPT pushrod using equipment described in Section 3.1.

#### **3.2.2.1 Pre-Placement Activities**

All necessary digging, drilling, and ground water monitoring point installation permits will be obtained prior to mobilizing to the field. In addition, all utility lines will be located, and proposed drilling locations will be cleared prior to any intrusive activities. Responsibilities for these permits and clearances are discussed in Section 3.1.1.

Water to be used in monitoring point installation and equipment cleaning will be obtained from one of the Base water supplies. Water use approval will be verified by contacting the appropriate facility personnel. The field scientist will make the final determination as to the suitability of site water for these activities.



### **3.2.2.2 Ground Water Monitoring Point Installation**

#### ***3.2.2.2.1 Monitoring Point Materials Decontamination***

Monitoring point completion materials will be inspected by the field scientist and determined to be clean and acceptable prior to use. If not factory sealed, casing, screen, and casing plugs and caps will be cleaned prior to use with a high-pressure, steam/hot-water cleaner using approved water. Materials that cannot be cleaned to the satisfaction of the field scientist will not be used.

#### ***3.2.2.2.2 Monitoring Point Screen and Casing***

Ground water monitoring points will be installed by attaching 0.75-inch OD/0.5-inch ID PVC casing and screen to a sacrificial tip and threading the casing/screen through the penetrometer pushrod. As the pushrod is pressed into the ground, new 0.75-inch OD/0.5-inch ID PVC casing will be continuously attached until the desired depth is reached and a fully cased monitoring point is created. Data collection devices such as CPT and LIF will not be used during monitoring point placement; however, a CPT test will be performed at each monitoring point location prior to monitoring point placement in order to select desired screen depths.

Monitoring point casing and screens will be constructed of flush-threaded, Schedule 40 PVC. The screens will be factory slotted with 0.01-inch openings. Casing joints will not be glued. The PVC top cap will be vented to maintain ambient atmospheric pressure if the monitoring point is completed abovegrade. The PVC top cap for monitoring points completed at or below grade will not be vented to minimize the potential for surface water entering the point.

The field scientist will verify and record the total depth of the monitoring point, the lengths of all casing sections, and the depth to the top of all monitoring point completion materials. All lengths and depths will be recorded to the nearest 0.1 foot. Monitoring point construction details will be noted on a Monitoring Point Installation Record form (Figure 3.5). This information will become part of the permanent field record for the site.

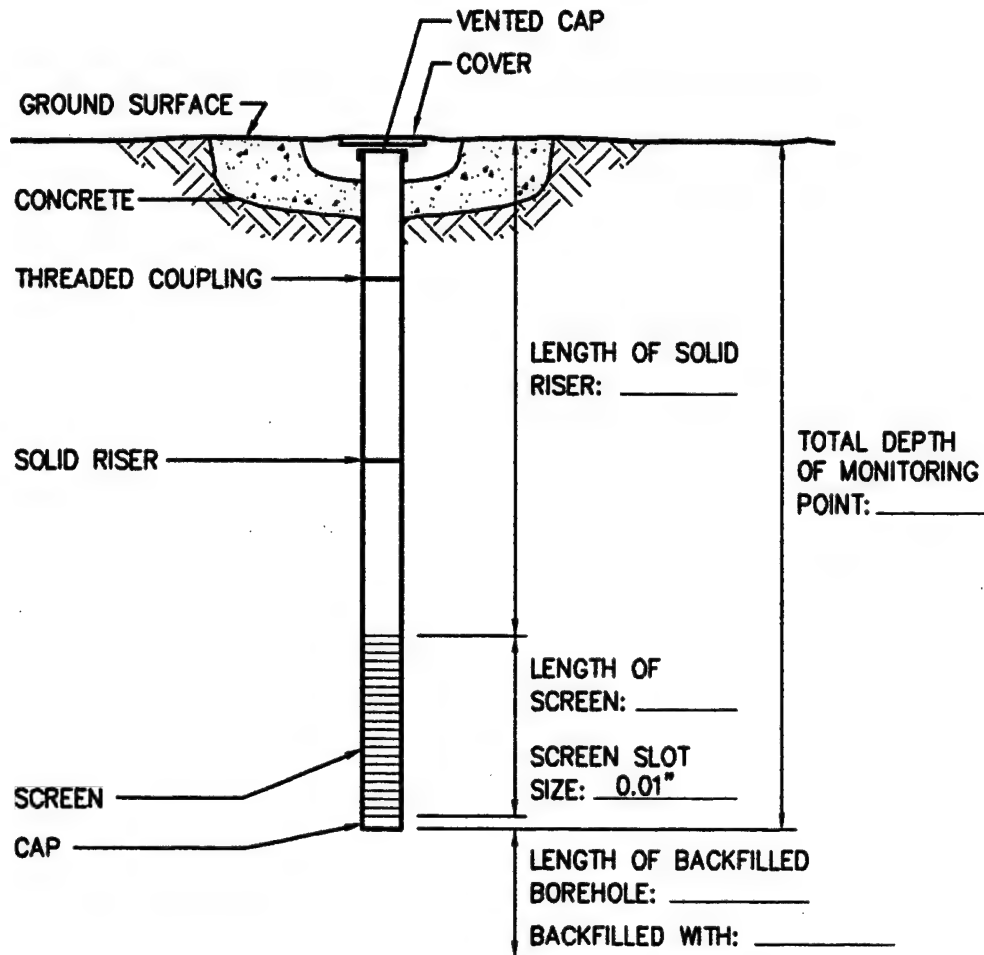
#### **3.2.2.3 Above-Grade and At-Grade Well Completion**

Each monitoring point will be completed with an at-grade protective cover or an above-grade protector pipe. In areas where pavement is present, the at-grade cover will be cemented in place using concrete blended to the existing pavement; otherwise, a concrete pad will be installed around the monitoring point. The concrete immediately surrounding the monitoring point will be sloped gently away from the protective casing to facilitate runoff during precipitation events. For above-grade completions, a steel protector pipe will be installed around the monitoring point riser in order to protect the riser from damage. Each pipe will be painted a color designated by Base personnel and cemented into a 1-foot-square pad to ensure the stability of the post.



# MONITORING POINT INSTALLATION RECORD

JOB NAME MYRTLE BEACH - AIR FORCE BASE MONITORING POINT NUMBER \_\_\_\_\_  
 JOB NUMBER 722450.22 INSTALLATION DATE \_\_\_\_\_ LOCATION \_\_\_\_\_  
 DATUM ELEVATION \_\_\_\_\_ GROUND SURFACE ELEVATION \_\_\_\_\_  
 DATUM FOR WATER LEVEL MEASUREMENT \_\_\_\_\_  
 SCREEN DIAMETER & MATERIAL \_\_\_\_\_ SLOT SIZE \_\_\_\_\_  
 RISER DIAMETER & MATERIAL \_\_\_\_\_ BOREHOLE DIAMETER \_\_\_\_\_  
 CONE PENETROMETER CONTRACTOR \_\_\_\_\_ ES REPRESENTATIVE \_\_\_\_\_



(NOT TO SCALE)

STABILIZED WATER LEVEL \_\_\_\_\_ FEET  
 BELOW DATUM.  
 TOTAL MONITORING POINT DEPTH \_\_\_\_\_ FEET  
 BELOW DATUM.  
 GROUND SURFACE \_\_\_\_\_ FEET

**FIGURE 3.5**

## MONITORING POINT INSTALLATION RECORD

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#### **3.2.2.4 Monitoring Point Development**

New monitoring points will be developed prior to sampling. Development removes sediment from inside the monitoring point casing and flushes fines from the portion of the formation adjacent to the monitoring point screen.

Monitoring point development will be accomplished using a peristaltic pump with dedicated tubing provided by Parsons ES. The pump tubing will be regularly lowered to the bottom of the monitoring point so that fines which have accumulated in the bottom are agitated and removed from the monitoring point.

Development will be continued until a minimum 10 casing volumes of water has been removed from the monitoring point and until pH, temperature, specific conductivity, DO, and water clarity (turbidity) stabilize. If the water remains turbid, monitoring point development will continue until the turbidity of the water produced has been stable after the removal of several casing volumes.

A monitoring point development record will be maintained for each point. The monitoring point development record will be completed in the field by the field scientist. Figure 3.6 is an example of the monitoring point development record. Development records will include:

- Monitoring point number;
- Date and time of development;
- Development method;
- Predevelopment water level and monitoring point depth;
- Volume of water produced;
- Description of water produced;
- Postdevelopment water level and monitoring point depth; and
- Field analytical measurements, including pH and specific conductivity.

Development waters will be collected in 55-gallon drums. Filled 55-gallon drums will be placed on pallets and transported by Base personnel to the Base's designated hazardous waste collection area.

#### **3.2.2.5 Water Level Measurements**

Water levels at existing monitoring wells and newly installed monitoring points will be measured within a short time period so that the water level data are comparable. The depth to water below the measurement datum will be measured to the nearest 0.01 foot using an electric water level probe.

# MONITORING POINT DEVELOPMENT RECORD

Page\_\_ of\_\_

Job Number: \_\_\_\_\_  
Location \_\_\_\_\_  
Well Number \_\_\_\_\_

Job Name: \_\_\_\_\_  
By \_\_\_\_\_ Date \_\_\_\_\_  
Measurement Datum \_\_\_\_\_

## Pre-Development Information

Time (Start): \_\_\_\_\_

Water Level: \_\_\_\_\_

Total Depth of Well: \_\_\_\_\_

### Water Characteristics

Color \_\_\_\_\_ Clear Cloudy  
Odor: None Weak Moderate Strong  
Any Films or Immiscible Material \_\_\_\_\_  
pH \_\_\_\_\_ Temperature(<sup>o</sup>F <sup>o</sup>C) \_\_\_\_\_  
Specific Conductance( $\mu$ S/cm) \_\_\_\_\_

## Interim Water Characteristics

Gallons Removed \_\_\_\_\_

pH \_\_\_\_\_

Temperature (<sup>o</sup>F <sup>o</sup>C) \_\_\_\_\_

Specific Conductance( $\mu$ S/cm) \_\_\_\_\_

## Post-Development Information

Time (Finish): \_\_\_\_\_

Water Level: \_\_\_\_\_

Total Depth of Well: \_\_\_\_\_

Approximate Volume Removed: \_\_\_\_\_

### Water Characteristics

Color \_\_\_\_\_ Clear Cloudy  
Odor: None Weak Moderate Strong  
Any Films or Immiscible Material \_\_\_\_\_  
pH \_\_\_\_\_ Temperature(<sup>o</sup>F <sup>o</sup>C) \_\_\_\_\_  
Specific Conductance( $\mu$ S/cm) \_\_\_\_\_

Comments: \_\_\_\_\_

FIGURE 3.6

## MONITORING POINT DEVELOPMENT RECORD

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### **3.2.2.6 Monitoring Point Location and Datum Survey**

The location and elevation of the new monitoring points will be surveyed soon after point completion. The horizontal location will be measured relative to established Base coordinates. Horizontal coordinates will be measured to the nearest 0.1 foot. The elevation of the ground surface adjacent to the monitoring point casing and the measurement datum elevation (top of PVC casing) will be measured relative to the USGS msl datum. The ground surface elevation will be measured to the nearest 0.1 foot and the measurement datum, outer casing, and surveyor's pin (if present) elevation will be measured to the nearest 0.01 foot.

### **3.2.3 Site Restoration**

After monitoring point installation and sampling is complete, each site will be restored around the finished monitoring point as closely as possible to its original condition. Both clean and contaminated development waters and sampling purge waters will be stored in 55-gallon drums and transported by Base personnel to the designated area used for collection of hazardous wastes at the Base.

## **3.3 TEMPORARY MONITORING POINT INSTALLATION**

Clusters of two temporary monitoring points will be installed at three locations on the north side of the drainage ditch at the leading edge of the dissolved BTEX plume. The temporary monitoring points will be installed at the edge of the drainage ditch, 5 feet from the drainage ditch, and 10 feet from the drainage ditch at locations which lie approximately along the dissolved BTEX plume axis (Figure 3.4). Ground water samples will be collected at these locations to determine the contaminant concentration gradient at the edge of the drainage ditch and the contaminant concentration of ground water which is available for discharge to the drainage ditch.

Temporary ground water sampling points will be constructed by driving Geoprobe® ground water sampling rods into the ground. The lowermost 18 inches of the sampling rods consists of slotted-steel. Upon achieving the desired sampling depth, 3/8-inch, high-density polyethylene (HDPE) tubing will be threaded through the center of the hollow Geoprobe® sampling rods. Purging and sampling of ground water at the temporary monitoring points will proceed with a peristaltic pump as described in Section 3.4.

## **3.4 GROUND WATER SAMPLING**

This section describes the scope of work required for collection of ground water quality samples. Samples will be collected from existing monitoring wells (i.e., wells MW-01 through MW-11, MW-33 through MW-36, and MW-44), newly installed ground water monitoring points, and temporary Geoprobe® monitoring points. A peristaltic pump with dedicated HDPE tubing will be used to collect ground water samples. In order to maintain a high degree of QC during this sampling event, the procedures described in the following sections will be followed.

Sampling will be conducted by qualified scientists and technicians from Parson ES and the EPA/Robert S. Kerr Research Laboratory (RSKERL) who are trained in the conduct of ground water sampling, records documentation, and chain-of-custody procedures. In addition, sampling personnel will have thoroughly reviewed this work plan prior to sample acquisition and will have a copy of the work plan available onsite for reference. The following activities will occur during ground water sampling:

- Assembly and preparation of equipment and supplies;
- Inspection of the monitoring well/point integrity including:
  - Protective cover, cap, and lock,
  - External surface seal and pad,
  - Monitoring point stick-up, cap, and datum reference, and
  - Internal surface seal;
- Ground water sampling, including
  - Water level and product thickness measurements,
  - Visual inspection of sample water,
  - Monitoring point casing evacuation, and
  - Sample collection;
- Sample preservation and shipment, including
  - Sample preparation,
  - Onsite measurement of physical parameters, and
  - Sample labeling;
- Completion of sampling records: and
- Sample disposition.

Detailed ground water sampling and sample handling procedures are presented in following sections.

### **3.4.1 Preparation for Sampling**

All equipment to be used for sampling will be assembled and properly cleaned and calibrated (if required) prior to arriving in the field. In addition, all record-keeping materials will be gathered prior to leaving the office.

#### **3.4.1.1 Equipment Cleaning**

All portions of sampling and test equipment that will contact the sample matrix will be thoroughly cleaned before each use. This includes the CPT soil sampling tool, water level probe and cable, lifting line, test equipment for onsite use, and other equipment or

portions thereof that will contact the samples. Based on the types of sample analyses to be conducted, the following cleaning protocol will be used:

- Wash with potable water and phosphate-free laboratory detergent (HP-II detergent solutions, as appropriate);
- Rinse with potable water;
- Rinse with isopropanol;
- Rinse with distilled or deionized water; and
- Air dry the equipment prior to use.

Any deviations from these procedures will be documented in the field scientist's field notebook and on the Ground Water Sampling Record (Figure 3.7).

If precleaned disposable sampling equipment is used, the cleaning protocol specified above will not be required. Laboratory-supplied sample containers will be cleaned and sealed by the laboratory. The type of container provided and the method of container decontamination will be documented in the EPA mobile laboratory's permanent record of the sampling event.

#### **3.4.1.2 Equipment Calibration**

As required, field analytical equipment will be calibrated according to the manufacturers' specifications prior to field use. This applies to equipment used for onsite measurements of DO, pH, electrical conductivity, temperature, reduction/oxidation (redox) potential, sulfate, nitrate, ferrous iron ( $\text{Fe}^{2+}$ ), and other field parameters listed on Table 3.1.

#### **3.4.2 Sampling Procedures**

Special care will be taken to prevent contamination of the ground water and extracted samples. The two primary ways in which sample contamination can occur are through contact with improperly cleaned equipment and through cross-contamination due to insufficient cleaning of equipment between wells and monitoring points. To prevent such contamination, the water level probe and cable used to determine static water levels and total well depths will be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in Section 3.3.2.1. Dedicated tubing will be used at each well or monitoring point developed, purged, and/or sampled with the peristaltic pump. The nondisposable bailers will be decontaminated according to procedures listed in Section 3.3.2.1. In addition to the use of properly cleaned equipment, a clean pair of new, disposable nitrile or latex gloves will be worn each time a different well or monitoring point is sampled. Dedicated, disposable bailers may be used on the 2-inch ID existing wells. The following paragraphs present the procedures to be followed for ground water sample collection from ground water monitoring wells and monitoring points. These activities will be performed in the order

SAMPLING LOCATION \_\_\_\_\_  
SAMPLING DATE(S) \_\_\_\_\_

GROUND WATER SAMPLING RECORD - MONITORING WELL \_\_\_\_\_  
(number)

REASON FOR SAMPLING: ☐ Regular Sampling; ☐ Special Sampling;

DATE AND TIME OF SAMPLING: \_\_\_\_\_, 19\_\_\_\_ a.m./p.m.

SAMPLE COLLECTED BY: \_\_\_\_\_ of \_\_\_\_\_

WEATHER: \_\_\_\_\_

DATUM FOR WATER DEPTH MEASUREMENT (Describe): \_\_\_\_\_

MONITORING WELL CONDITION:

☐ LOCKED:

☐ UNLOCKED

WELL NUMBER (IS - IS NOT) APPARENT

STEEL CASING CONDITION IS: \_\_\_\_\_

INNER PVC CASING CONDITION IS: \_\_\_\_\_

WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT

☐ DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR

☐ MONITORING WELL REQUIRED REPAIR (describe): \_\_\_\_\_

Check-off

1 ☐

EQUIPMENT CLEANED BEFORE USE WITH \_\_\_\_\_

Items Cleaned (List): \_\_\_\_\_

2 ☐

PRODUCT DEPTH \_\_\_\_\_ FT. BELOW DATUM

Measured with: \_\_\_\_\_

WATER DEPTH \_\_\_\_\_ FT. BELOW DATUM

Measured with: \_\_\_\_\_

3 ☐

WATER-CONDITION BEFORE WELL EVACUATION (Describe):

Appearance: \_\_\_\_\_

Odor: \_\_\_\_\_

Other Comments: \_\_\_\_\_

4 ☐

WELL EVACUATION:

Method: \_\_\_\_\_

Volume Removed: \_\_\_\_\_

Observations: Water (slightly - very) cloudy  
Water level (rose - fell - no change)

Water odors: \_\_\_\_\_

Other comments: \_\_\_\_\_

FIGURE 3.7

GROUND WATER  
SAMPLING RECORD

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5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: \_\_\_\_\_  
[ ] Pump, type: \_\_\_\_\_  
[ ] Other, describe: \_\_\_\_\_

Sample obtained is [ ] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Temp: _____ °	Measured with: _____
pH: _____	Measured with: _____
Conductivity: _____	Measured with: _____
Dissolved Oxygen: _____	Measured with: _____
Redox Potential: _____	Measured with: _____
Salinity: _____	Measured with: _____
Nitrate: _____	Measured with: _____
Sulfate: _____	Measured with: _____
Ferrous Iron: _____	Measured with: _____
Other: _____	_____

7 [ ] SAMPLE CONTAINERS (material, number, size): \_\_\_\_\_

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration:      Method \_\_\_\_\_ Containers: \_\_\_\_\_  
                            Method \_\_\_\_\_ Containers: \_\_\_\_\_  
                            Method \_\_\_\_\_ Containers: \_\_\_\_\_

[ ] Preservatives added:

Method _____	Containers: _____
Method _____	Containers: _____
Method _____	Containers: _____
Method _____	Containers: _____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled  
[ ] Container Lids Taped  
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

FIGURE 3.7 (CONTINUED)

GROUND WATER  
SAMPLING RECORD

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presented below. Exceptions to this procedure will be noted in the field scientist's field notebook.

#### **3.4.2.1 Preparation of Location**

Prior to starting the sampling procedure, the area around the existing wells and new monitoring points will be cleared of foreign materials, such as brush, rocks, and debris. These procedures will prevent sampling equipment from inadvertently contacting debris around the monitoring well/point.

#### **3.4.2.2 Water Level and Total Depth Measurements**

Prior to removing any water from the monitoring well or monitoring point, the static water level will be measured. An electric water level probe will be used to measure the depth to ground water below the datum to the nearest 0.01 foot. After measuring the static water level, the water level probe will be slowly lowered to the bottom of the monitoring well/point and the depth will be measured to the nearest 0.01 foot. If free-phase product is present, the total depth of the well from installation records will be used to avoid excessive contamination of the water level probe and cord. Based on these measurements, the volume of water to be purged from the monitoring well/point will be calculated. If free-phase product is encountered, the thickness of the product will be measured with an oil/water interface probe.

#### **3.4.2.3 Monitoring Well/Point Purging**

The volume of water contained within the monitoring well/point casing at the time of sampling will be calculated, and three times the calculated volume will be removed from the well/point. All purge water will be placed in 55-gallon drums and disposed of by Base personnel in the Base's approved disposal location. Emptied 55-gallon drums will be handled by Base personnel. A Grundfos Redi-Flo 2<sup>®</sup> submersible pump will be used for monitoring well purging, a peristaltic pump will be used for monitoring point purging, depth permitting, and either a Waterra<sup>®</sup> inertial pump or bailer will be used to purge all monitoring points in which the other two pumps will not work.

If a monitoring well/point is evacuated to a dry state during purging, the monitoring well/point will be allowed to recharge, and the sample will be collected as soon as sufficient water is present in the monitoring well/point to obtain the necessary sample quantity. Sample compositing or sampling over a lengthy period by accumulating small volumes of water at different times to obtain a sample of sufficient volume will not be allowed.

#### **3.4.2.4 Sample Extraction**

Dedicated HDPE tubing and a peristaltic pump will be used to extract ground water samples from monitoring wells/points whenever depth to ground water permits; otherwise, a Waterra<sup>®</sup> inertial pump, Grundfos Redi-Flo 2<sup>®</sup> pump, or bailer will be used. The tubing, pump, or bailer will be lowered through the casing into the water gently to prevent splashing. The sample will be transferred directly into the appropriate sample

container. The water will be carefully poured down the inner walls of the sample bottle to minimize aeration of the sample.

Unless other instructions are given by the EPA mobile laboratory, sample containers will be completely filled so that no air space remains in the container. Excess water collected during sampling will be placed into the 55-gallon drums used for monitoring well/point purge waters and transported for disposal by Base personnel to the facilities designated by the Base.

### **3.4.3 Onsite Ground Water Parameter Measurement**

As indicated on Table 3.1, many of the ground water chemical parameters will be measured onsite by EPA/RSKERL staff. Some of the measurements will be made with direct-reading meters, while others will be made using of a HACH<sup>®</sup> portable colorimeter in accordance with specific HACH<sup>®</sup> analytical procedures. These procedures are described in the following subsections.

All glassware or plasticware used in the analyses will have been cleaned prior to sample collection by thoroughly washing with a solution of Alconox<sup>®</sup> and water, and rinsing with deionized water and ethanol to prevent interference or cross contamination between measurements. If concentrations of an analyte are above the range detectable by the titrimetric method, the analysis will be repeated by diluting the ground water sample with double-distilled water until the analyte concentration falls to a level within the range of the method. All rinseate and sample reagents accumulated during ground water analysis will be collected in glass containers fitted with screw caps. These waste containers will be clearly labeled as to their contents and carefully stored for later transfer by Base personnel to the approved disposal facility.

#### **3.4.3.1 Dissolved Oxygen Measurements**

DO measurements will be made using a meter with a downhole oxygen sensor or a sensor in a flow-through cell before and immediately following ground water sample acquisition. When DO measurements are taken in monitoring wells/points that have not yet been sampled, the existing monitoring wells/points will be purged until DO levels stabilize.

#### **3.4.3.2 pH, Temperature, and Specific Conductance**

Because the pH, temperature, and specific conductance of a ground water sample can change significantly within a short time following sample acquisition, these parameters will be measured in the field in unfiltered, unpreserved, "fresh" water collected by the same technique as the samples taken for laboratory analyses. The measurements will be made in a clean glass container separate from those intended for laboratory analysis, and the measured values will be recorded in the ground water sampling record (Figure 3.7).

### **3.4.3.3 Alkalinity Measurements**

Alkalinity in ground water helps buffer the ground water system against acids generated through both aerobic and anaerobic biodegradation processes. Alkalinity of the ground water sample will be measured in the field by experienced EPA/RSKERL scientists via titrimetric analysis using EPA-approved HACH® Method 8221 (0 to 5,000 mg/L as calcium carbonate) or similar.

### **3.4.3.4 Nitrate- and Nitrite-Nitrogen Measurements**

Nitrate-nitrogen concentrations are of interest because nitrate can act as an electron acceptor during hydrocarbon biodegradation under anaerobic soil or ground water conditions. Nitrate-nitrogen is also a potential nitrogen source for biomass formation for hydrocarbon-degrading bacteria. Nitrite-nitrogen is an intermediate byproduct in both ammonia nitrification and in nitrate reduction in anaerobic environments.

Nitrate- and nitrite-nitrogen concentrations in ground water will be measured in the field by experienced EPA/RSKERL scientists via colorimetric analysis using a HACH® DR/700 Portable Colorimeter. Nitrate concentrations in ground water samples will be analyzed after preparation with HACH® Method 8039 (0 to 30.0 mg/L NO<sub>3</sub>). Nitrite concentrations in ground water samples will be analyzed after preparation with EPA-approved HACH® Method 8507 (0 to 0.35 mg/L NO<sub>2</sub>) or similar.

### **3.4.3.5 Sulfate and Sulfide Sulfur Measurements**

Sulfate in ground water is a potential electron acceptor for fuel-hydrocarbon biodegradation in anaerobic environments, and sulfide is resultant after sulfate reduction. An EPA/RSKERL scientist will measure sulfate and sulfide concentrations via colorimetric analysis with a HACH® DR/700 Portable Colorimeter after appropriate sample preparation. EPA-approved HACH® Methods 8051 (0 to 70.0 mg/L SO<sub>4</sub>) or similar and 8131 (0.60 mg/L S<sup>2-</sup>) or similar will be used to prepare samples and analyze sulfate and sulfide concentrations, respectively.

### **3.4.3.6 Total Iron, Ferrous Iron, and Ferric Iron Measurements**

Iron is an important trace nutrient for bacterial growth, and different states of iron can affect the oxidation/reduction potential of the groundwater and act as an electron acceptor for biological metabolism under anaerobic conditions. Iron concentrations will be measured in the field via colorimetric analysis with a HACH® DR/700 Portable Colorimeter after appropriate sample preparation. HACH® Method 8008 or similar for total soluble iron (0 to 3.0 mg/L Fe<sup>3+</sup> + Fe<sup>2+</sup>) and HACH® Method 8146 or similar for ferrous iron (0 to 3.0 mg/L Fe<sup>2+</sup>) will be used to prepare and quantitate the samples. Ferric iron will be quantitated by subtracting ferrous iron levels from total iron levels.

### **3.4.3.7 Manganese Measurements**

Manganese is a potential electron acceptor under anaerobic environments. Manganese concentrations will be quantitated in the field using colorimetric analysis with a HACH®

DR/700 Portable Colorimeter. EPA approved HACH® Method 8034 (0 to 20.0 mg/L) or similar will be used for quantitation of manganese concentrations. Sample preparation and disposal procedures are outlined earlier in Section 3.3.4.

#### **3.4.3.8 Redox Potential**

The reduction/oxidation (redox) potential of ground water is an indication of the relative tendency of a solution to accept or transfer electrons. Redox reactions in ground water are usually biologically mediated; therefore, the redox potential of a ground water system depends upon and influences rates of biodegradation. Redox potential can be used to provide real-time data on the location of the contaminant plume, especially in areas undergoing anaerobic biodegradation. The redox potential of a ground water sample taken inside the contaminant plume should be somewhat less than that taken in the upgradient location.

The redox potential of a ground water sample can change significantly within a short time following sample acquisition and exposure to atmospheric oxygen. As a result, this parameter will be measured in the field in unfiltered, unpreserved, "fresh" water collected by the same technique as the samples taken for laboratory analyses. The measurements will be made as quickly as possible in a clean glass container separate from those intended for laboratory analysis.

### **3.5 SAMPLE HANDLING FOR LABORATORY ANALYSIS**

This section describes the handling of samples from the time of sampling until the samples are delivered to EPA mobile laboratory.

#### **3.5.1 Sample Preservation**

The EPA laboratory support personnel will add any necessary chemical preservatives prior to filling the sample containers. Samples will be prepared for transportation to the analytical laboratory by placing the samples in a cooler containing ice to maintain a shipping temperature of 4 degrees centigrade (°C). Samples will be delivered promptly to EPA mobile laboratory personnel, who will be responsible for shipment of appropriate samples to the RSKERL in Ada, Oklahoma for analysis.

#### **3.5.2 Sample Container and Labels**

Sample containers and appropriate container lids will be provided by the EPA mobile laboratory (see Appendix A). The sample containers will be filled as described in Section 3.3.3.2.4, and the container lids will be tightly closed. The sample label will be firmly attached to the container side, and the following information will be legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Sample type (e.g., ground water, soil);

- Sampling date;
- Sampling time;
- Preservatives added;
- Sample collector's initials; and
- Requested analyses.

### **3.5.3 Sample Shipment**

After the samples are sealed and labeled, they will be packaged for transport to the onsite EPA mobile laboratory. The following packaging and labeling procedures will be followed:

- Package sample so that it will not leak, spill, or vaporize from its container;
- Cushion samples to avoid breakage; and
- Add ice to container to keep samples cool.

The packaged samples will be delivered by hand to the EPA mobile laboratory. Delivery will occur as soon as possible after sample acquisition.

### **3.5.4 Chain-of-Custody Control**

Chain-of-custody documentation for the shipment of samples from the EPA mobile laboratory to the EPA/RSKERL analytical laboratory in Ada, Oklahoma, will be the responsibility of the EPA/RSKERL field personnel.

### **3.5.5 Sampling Records**

In order to provide complete documentation of the sampling event, detailed records will be maintained by the field scientist. At a minimum, these records will include the following information:

- Sample location (facility name);
- Sample identification;
- Sample location map or detailed sketch;
- Date and time of sampling;
- Sampling method;
- Field observations of
  - Sample appearance, and
  - Sample odor;
- Weather conditions;
- Water level prior to purging (ground water samples, only);

- Total monitoring well/point depth (ground water samples, only);
- Sample depth (soil samples, only);
- Purge volume (ground water samples, only);
- Water level after purging (ground water samples, only);
- Monitoring well/point condition (ground water samples, only);
- Sampler's identification;
- Field measurements of pH, temperature, DO, and specific conductivity (ground water samples, only); and
- Any other relevant information.

Ground water sampling information will be recorded on a ground water sampling form. Figure 3.7 shows an example of the ground water sampling record. Soil sampling information will be recorded in the field log book.

### **3.5.6 Laboratory Analyses**

Laboratory analyses will be performed on all ground water and soil samples as well as the QA/QC samples described in Section 5. The analytical methods for this sampling event are listed in Table 3.1. Prior to sampling, EPA/RSKERL personnel will provide a sufficient number of analyte-appropriate sample containers for the samples to be collected. All containers, preservatives, and shipping requirements will be consistent with EPA protocol or those reported in Appendix A of this plan.

EPA/RSKERL laboratory support personnel will specify the necessary QC samples and prepare appropriate QC sample bottles. For samples requiring chemical preservation, preservatives will be added to containers by the laboratory. Containers, ice chests with adequate padding, and cooling media may be provided by EPA/RSKERL laboratory personnel. Sampling personnel will fill the sample containers and return the samples to the mobile laboratory.

## **3.6 AQUIFER TESTING**

Slug tests will be conducted on selected existing wells to estimate the hydraulic conductivity of unconsolidated sand and clay deposits at the site. This information is required to accurately estimate the velocity of ground water and contaminants in the shallow saturated zone. A slug test is a single-well hydraulic test used to determine the hydraulic conductivity of an aquifer in the immediate vicinity of the tested well. Slug tests can be used for both confined and unconfined aquifers that have a transmissivity of less than 7,000 square feet per day (ft<sup>2</sup>/day). Slug testing can be performed using either a rising head or a falling head test; at this site, both methods will be used in sequence.

### 3.6.1 Definitions

- **Hydraulic Conductivity (K).** A quantitative measure of the ability of porous material to transmit water; defined as the volume of water that will flow through a unit cross-sectional area of porous or fractured material per unit time under a unit hydraulic gradient.
- **Transmissivity (T).** A quantitative measure of the ability of an aquifer to transmit water. It is the product of the hydraulic conductivity and the saturated thickness.
- **Slug Test.** Two types of testing are possible: rising head and falling head tests. A slug test consists of adding a slug of water or a solid cylinder of known volume to the well to be tested or removing a known volume of water or cylinder and measuring the rate of recovery of water level inside the well. The slug of a known volume acts to raise or lower the water level in the well.
- **Rising Head Test.** A test used in an individual well within the saturated zone to estimate the hydraulic conductivity of the surrounding formation by lowering the water level in the well and measuring the rate of recovery of the water level. The water level may be lowered by pumping, bailing, or removing a submerged slug from the well.
- **Falling Head Test.** A test used in an individual well to estimate the hydraulic conductivity of the surrounding formation by raising the water level in the well by insertion of a slug or quantity of water, and then measuring the rate of drop in the water level.

### 3.6.2 Equipment

The following equipment will be used to conduct a slug test:

- Teflon®, PVC, or metal slugs;
- Nylon or polypropylene rope;
- Electric water level indicator;
- Pressure transducer/sensor;
- Field logbook/forms; and
- Automatic data recording instrument (such as the Hermit Environmental Data Logger®, In-Situ, Inc. Model SE1000B, or equivalent).

### 3.6.3 General Test Methods

Aquifer hydraulic conductivity tests (slug tests) are accomplished by either removal of a slug or quantity of water (rising head) or introduction of a slug (falling head), and then allowing the water level to stabilize while taking water level measurements at closely spaced time intervals.



Because hydraulic testing will be completed on existing wells, it will be assumed that the wells were properly developed and that water levels have stabilized. Slug testing will proceed only after multiple water level measurements over time show that static water levels are in equilibrium. During the slug test, the water level change should be influenced only by the introduction (or removal) of the slug volume. Other factors, such as inadequate well development or extended pumping may lead to inaccurate results; slug tests will not be performed on wells with free product. The field scientist will determine when static equilibrium has been reached in the well. The pressure transducer, slugs, and any other downhole equipment will be decontaminated prior to and immediately after the performance of each slug test using the procedures described in Section 3.3.2.1.

#### **3.6.4 Falling Head Test**

The falling head test is the first step in the two-step slug-testing procedure. The following paragraphs describe procedures to be followed during performance of the falling head test.

1. Decontaminate all downhole equipment prior to initiating the test.
2. Open the well. Where wells are equipped with water tight caps, the well should be unsealed at least 24 hours prior to testing to allow the water level to stabilize. The protective casing will remain locked during this time to prevent vandalism.
3. Prepare the Aquifer Slug Test Data Form (Figure 3.8) with entries for:
  - Borehole/well number,
  - Project number,
  - Project name,
  - Aquifer testing team,
  - Climatic data,
  - Ground surface elevation,
  - Top of well casing elevation,
  - Identification of measuring equipment being used,
  - Page number,
  - Static water level, and
  - Date.
4. Measure the static water level in the well to the nearest 0.01 foot.
5. Lower the decontaminated pressure transducer into the well and allow the displaced water to return to its static level. This can be determined by periodic water level measurements until the static water level in the well is within 0.01 foot of the original static water level.



[illegible]

Denver, Colorado

6. Lower the decontaminated slug into the well to just above the water level in the well.
7. Turn on the data logger and quickly lower the slug below the water table, being careful not to disturb the pressure transducer. Follow the owner's manual for proper operation of the data logger.
8. Terminate data recording when the water level stabilizes in the well. The well will be considered stabilized for termination purposes when it has recovered 80 to 90 percent from the initial slug.

### **3.6.5 Rising Head Test**

After completion of the falling head test, the rising head test will be performed. The following paragraphs describe the rising head slug test procedure.

1. Measure the water level in the well to the nearest 0.01 foot to ensure that it has returned to the static water level.
2. Initiate data recording and quickly withdraw the slug from the well. Follow the owner's manual for proper operation of the data logger.
3. Terminate data recording when the water level stabilizes in the well, and remove the pressure transducer from the well and decontaminate. The well will be considered stabilized for termination purposes when it has recovered 80 to 90 percent from the initial slug.

### **3.6.6 Slug Test Data Analysis**

Data obtained during slug testing will be analyzed using AQTESOLV™ and the method of Hvorslev (1951) for confined aquifers or the method of Bouwer and Rice (1976) and Bouwer (1989) for unconfined conditions.

## SECTION 4

### REMEDIAL OPTION EVALUATION AND CAP REPORT

Upon completion of field work, the Bioplume II numerical ground water model will be used to determine the fate and transport of fuel hydrocarbons dissolved in ground water at the site. Based upon model predictions of contaminant concentrations and distribution through time, and upon potential exposure pathways, the potential risk to human health and the environment will be assessed. If it is shown that intrinsic remediation of BTEX compounds at the site is sufficient to reduce the potential risk to human health and the environment to acceptable levels, Parsons ES will recommend implementation of the intrinsic remediation option. If intrinsic remediation is chosen, Parsons ES will prepare a site-specific, long-term monitoring plan that will specify the location of point-of-compliance monitoring wells and sampling frequencies.

If the intrinsic remediation remedial option is deemed inappropriate for use at this site, institutional controls such as ground water or land use restrictions will be evaluated to determine if they will be sufficient to reduce the risk to human health and the environment to acceptable levels. If institutional controls are inappropriate, remedial options which could reduce risks to acceptable levels will be evaluated and the most appropriate remedial options will be recommended. Potential remedial options include, but are not limited to, free-product recovery, ground water pump-and-treat, enhanced biological treatment, bioventing, air sparging, and *in situ* reactive barrier walls. The reduction in dissolved BTEX that should result from remedial activities will be used to produce a new input file for the Bioplume II model. The model will then be used to predict the BTEX plume (and risk) reduction that should result from remedial actions.

Upon completion of Bioplume II modeling and remedial option selection, an CAP report detailing the results of the modeling and remedial option selection will be prepared. The remedial pilot studies completed under the CAP at the MOGAS site by Parsons Engineering Science, Inc. will be integrated into the remedial option analysis in this CAP. This report will follow the outline presented in Table 4.1 and will contain an introduction, site description, identification of remediation objectives, description of remediation alternatives, an analysis of remediation alternatives, and the recommended remedial approach. This report will also contain the results of the site characterization activities described herein and a description of the Bioplume II model simulations developed for this site.

**TABLE 4.1**  
**EXAMPLE EE/CA REPORT OUTLINE**  
**MYRTLE BEACH AIR FORCE BASE**  
**SOUTH CAROLINA**

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**INTRODUCTION**

Scope and Objectives  
Site Background

**SITE CHARACTERIZATION ACTIVITIES**

CPT, Sampling, and Aquifer Testing Procedures

**PHYSICAL CHARACTERISTICS OF THE STUDY AREA**

Surface Features  
Regional Geology and Hydrogeology  
Site Geology and Hydrogeology  
Climatological Characteristics

**NATURE AND EXTENT OF CONTAMINATION**

Source Characterization  
Soil Chemistry  
    Residual-Phase Contamination  
    Total Organic Carbon  
Ground Water Chemistry  
    LNAPL Contamination  
    Dissolved Contamination  
    Ground Water Geochemistry  
    Expressed Assimilative Capacity

**GROUND WATER MODEL**

Model Description  
Conceptual Model Design and Assumptions  
Initial Model Setup  
Model Calibration  
Sensitivity Analysis  
Model Results  
Conclusions

**COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES**

Remedial Alternative Evaluation Criteria  
    Long-Term Effectiveness  
    Implementability (Technical, Administrative)  
    Cost (Capital, Operating, Present Worth)  
Factors Influencing Alternatives Development  
    Program Objectives  
    Contaminant Properties  
    Site-Specific Conditions  
Brief Description of Remedial Alternatives  
    Intrinsic Remediation with Long-Term Monitoring  
    Other Alternatives  
Evaluation of Alternatives  
Recommended Remedial Approach

**TABLE 4.1 (Continued)**  
**EXAMPLE EE/CA REPORT OUTLINE**  
**MYRTLE BEACH AIR FORCE BASE**  
**SOUTH CAROLINA**

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**LONG-TERM MONITORING PLAN**

Overview  
Monitoring Networks  
Ground Water Sampling

**CONCLUSIONS AND RECOMMENDATIONS**

How does the recommended technology offer adequate protection for less cost.

**APPENDICES: Supporting Data and Documentation**

Site-Specific Bioplume II Model Input and Results

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## SECTION 5

### QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC procedures will include collection of field duplicates and rinseate, field, and trip blanks; decontamination of all equipment that contacts the sample medium before and after each use; use of analyte-appropriate containers; and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to an onsite or offsite analytical laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., ground water), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used and packaged in coolers with ice to maintain a temperature of 4°C.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature. Field QC samples will be collected in accordance with the program described below, and as summarized in Table 5.1.

QA/QC sampling will include collection and analysis of duplicate samples, rinseate blanks, field/trip blanks, and matrix spike/matrix spike duplicate samples. Internal laboratory QC analyses will involve the analysis of laboratory control samples (LCSs) and laboratory method blanks (LMBs). QA/QC objectives for each of these samples, blanks, and spikes are described below.

One duplicate sample will be collected for every 10 or fewer samples collected, both for ground water and soils. Volume permitting, duplicate samples will be collected at locations where low to moderate levels of contamination are believed to be present.

One rinseate sample will be collected for every 10 or fewer ground water samples collected from existing wells. If disposable bailers are used for this sampling event, the rinseate sample will consist of a sample of distilled water poured into a new disposable bailer and subsequently transferred into a sample container provided by the laboratory. Rinseate samples will be analyzed for VOCs by Methods SW8020 or equivalent RSKERL method.

A field blank will be collected for every 20 or fewer ground water samples (both from ground water monitoring point and existing ground water monitoring well sampling events) to assess the effects of ambient conditions in the field. The field blank will consist of a sample of distilled water poured into a laboratory-supplied sample container

TABLE 5.1  
QA/QC SAMPLING PROGRAM

MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

QA/QC Sample Types	Frequency to be Collected and/or Analyzed	Analytical Methods
Duplicates	10% of Samples per Matrix a/	VOCs, TPH
Rinseate Blanks	10% of Ground Water Samples a/	VOCs
Field Blanks	5% of Ground Water Samples a/	VOCs
Trip Blanks	One per shipping cooler containing VOC samples	VOCs
Matrix Spike Samples	Once per sampling event	VOCs
Laboratory Control Sample	Once per method per medium	Laboratory Control Charts (Method Specific)
Laboratory Method Blanks	Once per method per medium	Laboratory Control Charts (Method Specific)

a/ Rounded to the next highest whole number.



while sampling activities are underway. The field blank will be analyzed for VOCs by Methods SW8020 or equivalent RSKERL method.

A trip blank will be analyzed to assess the effects of ambient conditions on sampling results during the transportation of samples. The trip blank will be prepared by the laboratory. A trip blank will be transported inside each cooler which contains samples for VOC analysis. Trip blanks will be analyzed for VOCs.

Matrix spikes will be prepared in the laboratory and used to establish matrix effects for samples analyzed for VOCs.

LCSs and LMBs will be prepared internally by the laboratory and will be analyzed each day samples from the site are analyzed. Samples will be reanalyzed in cases where the LCS or LMB are out of the control limits. Control charts for LCSs and LMBs will be developed by the laboratory and monitored for the analytical methods used.

## SECTION 6

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**APPENDIX A**

**CONTAINERS, PRESERVATIVES, PACKAGING, AND SHIPPING  
REQUIREMENTS FOR GROUND WATER SAMPLES**

# Appendix A - Soil, Soil Gas, and Ground Water Analytical Protocol

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Soil	Volatile organics	Gas chromatography/mass spectrometry method SW8240.	Handbook method	Data is used to determine the extent of chlorinated solvent and aromatic hydrocarbon contamination, contaminant mass present, and the need for source removal	Each sampling round	Collect 100 g of soil in a glass container with Teflon®-lined cap, cool to 4°C	Fixed-base
Soil	Aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylene [BTEX]; trimethylbenzene isomers)	Purge and trap gas chromatography (GC) method SW8020	Handbook method modified for field extraction of soil using methanol	Data is used to determine the extent of soil contamination, the contaminant mass present, and the need for source removal	Each sampling round	Collect 100 g of soil in a glass container with Teflon-lined cap, cool to 4°C	Fixed-base
Soil	Total organic carbon (TOC)	SW9060 modified for soil samples	Procedure must be accurate over the range of 0.5–15 percent TOC	Relatively high amounts of TOC may be indicative of a reducing environment and may indicate the need for analysis of electron acceptors associated with that environment; the rate of migration of petroleum contaminants in groundwater is dependent upon the amount of TOC in the saturated zone soil, the rate of release of petroleum contaminants from the source into groundwater is dependent (in part) on the amount of TOC in the vadose zone soil	At initial sampling	Collect 100 g of soil in a glass container with Teflon-lined cap, cool to 4°C	Fixed-base

Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Soil	Total hydrocarbons, volatile and extractable	GC method SW8015 [modified]	Handbook method; reference is the California LUST manual	Data are used to determine the extent of soil contamination, the contaminant mass present, and the need for source removal	Each sampling round	Collect 100 g of soil in a glass container with Teflon-lined cap; cool to 4°C	Fixed-base
Soil	Moisture	ASTM D-2216	Handbook method	Data are used to correct soil sample analytical results for moisture content (e.g., report results on a dry weight basis)	Each soil sampling round	Use a portion of soil sample collected for another analysis	Fixed-base
Soil	Grain size distribution	ASTM D422	Procedure provides a distribution of grain size by sieving	Data are used to infer hydraulic conductivity of aquifer, and are used in calculating sorption of contaminants	One time during life of project	Collect 250 g of soil in a glass or plastic container; preservation is unnecessary	Fixed-base
Soil gas	Oxygen content of soil gas	Electrochemical oxygen meter operating over the range of 0–25 percent of oxygen in the soil gas sample	The concentration of soil gas oxygen is often related to the amount of biological activity, such as the degradation of petroleum hydrocarbons; soil gas oxygen concentrations may decrease to the point where anaerobic pathways dominate	Data are used to understand the oxygen concentration gradient with depth and to determine the presence or absence of aerobic degradation processes	Each sampling round	N/A	Field



Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Soil gas	Carbon dioxide content of soil gas	Nondispersive infrared instrument operating over the range of approximately 0.1–15 percent	Soil gas carbon dioxide may be produced by the degradation of petroleum hydrocarbons	Data used to understand the carbon dioxide concentration gradient with depth and to infer the biological degradation of petroleum contaminants	Each sampling round	N/A	Field
Soil gas	Methane content of soil gas	Total combustible hydrocarbon meter using a platinum catalyst with a carbon trap, and operating in the low parts per million volume (ppmv) range	Methane is a product of the anaerobic degradation of petroleum hydrocarbons	Soil gas methane can be used to locate contaminated soil and to determine the presence of anaerobic processes; see discussion of data use for methane in water	Each sampling round	N/A	Field
Soil gas	Fuel hydrocarbon vapor content of soil gas	Total combustible hydrocarbon meter operating over a wide ppmv range	Soil gas hydrocarbons indicate the presence of these contaminants in the soil column	Data used to understand the petroleum hydrocarbon concentration gradient with depth and to locate the most heavily contaminated soils	Each sampling round	N/A	Field
Water	Ferrous ( $\text{Fe}^{+2}$ )	Colorimetric A3500-Fe D	Field only	May indicate an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese	Each sampling round	Collect 100 mL of water in a glass container; acidify with hydrochloric acid per method	Field
Water	Ferrous ( $\text{Fe}^{+2}$ )	Colorimetric HACH 25140-25	Alternate method; field only	May indicate an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese	Each sampling round	Collect 100 mL of water in a glass container	Field
Water	Temperature	E170.1	Field only	Well development	Each sampling round	N/A	Field



Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Chloride	Mercuric nitrate titration A4500-Cl <sup>-</sup> C	Ion chromatography (IC) method E300 or method SW9050 may also be used	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Each sampling round	Collect 250 mL of water in a glass container	Field
Water	Oxygen	Dissolved oxygen meter	Refer to method A4500 for a comparable laboratory procedure	The oxygen concentration is a data input to the Bioplume model; concentrations less than 1 mg/L generally indicate an anaerobic pathway	Each sampling round	Collect 300 mL of water in biochemical oxygen demand bottles; analyze immediately, alternately, measure dissolved oxygen <i>in situ</i>	Field
Water	pH	E150.1/SW9040, direct reading meter	Protocols/Handbook methods	Aerobic and anaerobic processes are pH-sensitive	Each sampling round	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field
Water	Conductivity	E120.1/SW9050, direct reading meter	Protocols/Handbook methods	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Each sampling round	Collect 100–250 mL of water in a glass or plastic container	Field
Water	Alkalinity	A2320, titrimetric; E310.2, colorimetric	Handbook method	General water quality parameter used (1) as a marker to verify that all site samples are obtained from the same groundwater system and (2) to measure the buffering capacity of groundwater	Each sampling round	Collect 250 mL of water in a glass or plastic container; analyze within 6 hours	Field

Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Nitrate ( $\text{NO}_3^-$ )	IC method E300 or method SW9056; colorimetric, method E353.2	Method E300 is a Handbook method; method SW9056 is an equivalent procedure	Substrate for microbial respiration if oxygen is depleted	Each sampling round	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C; analyze within 48 hours	Fixed-base
Water	Sulfate ( $\text{SO}_4^{2-}$ )	IC method E300 or method SW9056	Method E300 is a Handbook method; method SW9056 is an equivalent procedure	Substrate for anaerobic microbial respiration	Each sampling round	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Fixed-base
Water	Sulfate ( $\text{SO}_4^{2-}$ )	HACH Sulfa Ver 4 method	Photometric	Substrate for anaerobic microbial respiration	Each sampling round	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Field
Water	Redox potential	A2580 B	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of groundwater influences and is influenced by the nature of the biologically mediated degradation of contaminants; the redox potential of groundwater may range from more than 200 mV to less than -400 mV	Each sampling round	Collect 100–250 mL of water in a glass container, filling container from bottom; analyze immediately	Field
Water	Dissolved sulfide ( $\text{S}^{2-}$ )	Hach Model HS-C test kit	Procedure uses reagent-impregnated test strips to determine sulfide species (except insoluble metal sulfides) in the 0 to 5 mg/L range	Product of sulfate-based anaerobic microbial respiration; analyze in conjunction with sulfate analysis	Each sampling round	Collect 100 mL of water in a glass container; analyze immediately	Field

# Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Methane, carbon dioxide	RSKSOP-114 modified to analyze water samples for methane and carbon dioxide by headspace sampling with dual thermal conductivity and flame ionization detection (also, see reference in note 10)	Method published and used by the U.S. Environmental Protection Agency (EPA) Robert S. Kerr Laboratory	The presence of methane suggests BTEX degradation via an anaerobic pathway utilizing carbon dioxide (carbonate) as the electron acceptor (methanogenesis); a redox potential measurement of less than -200 mV could be indicative of methanogenesis and should be followed by the analysis referenced here; the presence of free carbon dioxide dissolved in groundwater is unlikely because of the carbonate buffering system of water, but if detected, the carbon dioxide concentrations should be compared with background to determine whether they are elevated, elevated concentrations of carbon dioxide could indicate an aerobic mechanism for bacterial degradation of petroleum	Each sampling round	Collect water samples in 40 mL volatile organic analysis (VOA) vials with butyl gray/Teflon-lined caps, cool to 4°C	Fixed-base

# Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
	Ethane, ethene	RSKSOP-114 (cont'd)	Ethane and ethene are analyzed in addition to the other analytes only if chlorinated hydrocarbons are contaminants suspected of undergoing biological transformation	Ethane and ethene are products of the biotransformation of chlorinated hydrocarbons under anaerobic conditions. The presence of these chemicals may indicate that anaerobic degradation is occurring			
Water	Carbon dioxide	HACH	Titrimetric; alternate method	The presence of free carbon dioxide dissolved in groundwater is unlikely because of the carbonate buffering system of water, but if detected, the carbon dioxide concentrations should be compared with background to determine whether they are elevated; elevated concentrations of carbon dioxide could indicate an aerobic mechanism for bacterial degradation of petroleum	Each sampling round	N/A	Field



Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Aromatic hydrocarbons (BTEX, trimethylbenzene isomers)	Purge and trap GC method SW8020	Handbook method; analysis may be extended to higher molecular weight alkyl benzenes	Method of analysis for BTEX, which is the primary target analyte for monitoring natural attenuation; BTEX concentrations must also be measured for regulatory compliance; method can be extended to higher molecular weight alkyl benzenes; trimethylbenzenes are used to monitor plume dilution if degradation is primarily anaerobic	Each sampling round	Collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH 2	Fixed-base
Water	Total hydrocarbons, volatile and extractable	GC method SW8015 [modified]	Handbook method; reference is the California LUFT manual	Data used to monitor the reduction in concentrations of total fuel hydrocarbons (in addition to BTEX) due to natural attenuation; data also used to infer presence of an emulsion or surface layer of petroleum in water sample, as a result of sampling	One time per year or as required by regulations	Volatile hydrocarbons—collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH 2 Extractable hydrocarbons—collect 1 L of water in a glass container; cool to 4°C; add hydrochloric acid to pH 2	Fixed-base
Water	Polycyclic aromatic hydrocarbons (PAHs) (optional)	GC/mass spectroscopy method SW8270; high-performance liquid chromatography method SW8310	Analysis needed only for several samples per site	PAHs are components of fuel and are typically analyzed for regulatory compliance; data on their concentrations are not used currently in the evaluation of natural attenuation	At initial sampling and at site closure or as required by regulations	Collect 1 L of water in a glass container; cool to 4°C	Fixed-base

# Appendix A (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Total fuel carbon (optional)	Purge and trap GC method SW8020 modified to measure all volatile aromatic hydrocarbons present in the sample	A substitute method for measuring total volatile hydrocarbons, reports amount of fuel as carbon present in the sample; method available from the U.S. EPA Robert S. Kerr Laboratory	Data used to monitor the reduction in concentrations of total fuel hydrocarbons (in addition to BTEX) due to natural attenuation	At initial sampling and at site closure	Collect 40 mL of water in glass vials with Teflon-lined caps; add sulfuric acid to pH 2; cool to 4°C	Fixed-base
Water	Volatile Organics	GS/MS method SW8240	Handbook method	Method of analysis for chlorinated solvents and aromatic hydrocarbons for evaluation of cometabolic degradation; measured for regulatory compliance when chlorinated solvents are known site contaminants	Each sampling round	Collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH 2	Fixed-base
Water	Dissolved organic carbon (DOC) (optional)	A5310 C	An oxidation procedure whereby carbon dioxide formed from DOC is measured by an infrared spectrometer. The minimum detectable amount of DOC is 0.05 mg/L.	An indirect index of microbial activity	Each sampling round	Collect 100 mL of water in an amber glass container with Teflon-lined cap; preserve with sulfuric acid to pH less than 2; cool to 4°C	Fixed-base

#### Appendix A (Concluded)

##### NOTES:

1. "HACH" refers to the HACH Company catalog, 1990.
2. "A" refers to *Standard Methods for the Examination of Water and Wastewater*, 18th edition, 1992.
3. "E" refers to *Methods for Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, March 1979.
4. "Protocols" refers to the AFCEE *Environmental Chemistry Function Installation Restoration Program Analytical Protocols*, 11 June 1992.
5. "Handbook" refers to the AFCEE *Handbook to Support the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS)*, September 1993.
6. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, U.S. Environmental Protection Agency, 3rd edition, 1986.
7. "ASTM" refers to the *American Society for Testing and Materials*, current edition.
8. "RSKSOP" refers to Robert S. Kerr (*Environmental Protection Agency Laboratory*) *Standard Operating Procedure*.
9. "LUFT" refers to the state of California *Leaking Underground Fuel Tank Field Manual*, 1988 edition.
10. *International Journal of Environmental Analytical Chemistry*, Volume 36, pp. 249-257, "Dissolved Oxygen and Methane in Water by a Gas Chromatography Headspace Equilibration Technique," by D. H. Kampbell, J. T. Wilson, and S. A. Vandegrift.



**APPENDIX B**

**AVAILABLE SOIL AND GROUND WATER ANALYTICAL  
RESULTS**

**HISTORICAL RESULTS SUMMARY**  
**GROUND WATER AND SURFACE WATER**

TABLE 1

HISTORICAL RESULTS SUMMARY  
GROUND WATER AND SURFACE WATER  
POL AREA

Former Myrtle Beach AFB, South Carolina

PARAMETER	UNITS	Sample Date:												MCL	SW-7 12/86	AMBIENT WATER (a) QUALITY STANDARD				
		GM - 33			GM - 34			GM - 35			GM - 44									
		1982	2/83	5/83	5/86	5/86	12/86	1982	2/83	5/83	5/86	5/86	12/86	1982	2/83	5/83	5/86	12/86		
VOCs																				
Benzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	0.000*	0.001	NA	0.025*	0.011**	NA	NA	ND	0.011*
Ethylbenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	0.400	0.004	NA	ND	0.0011	NA	NA	0.0036	ND
1,4-Dimethylbenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	ND	ND	NA	ND	0.0011	NA	NA	0.0043	ND
1,3-Dimethylbenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	ND	NA	0.240	ND	NA	NA	0.008	ND
1,2-Dimethylbenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	ND	NA	ND	0.014	ND	NA	0.014	ND
1,4-Dichlorobenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	ND	NA	0.032	ND	NA	NA	0.0068	ND
1,3-Dichlorobenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	ND	NA	ND	ND	NA	NA	0.0021	ND
Xylenes, Total	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	ND	NA	ND	0.067	NA	NA	ND	0.0062
Toluene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	ND	NA	ND	ND	NA	NA	ND	ND
Chlorobenzene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	0.010	ND	NA	ND	ND	NA	NA	ND	ND
1,2-Dichloroethene	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	0.005	NA	ND	ND	ND	NA	NA	ND	ND
TOX	mg/L	0.012	NA	NA	NA	NS	NS	0.020	NA	NA	NS	0.014	NA	NA	NA	NA	0.020	NA	NA	NA
TOC	mg/L	4.8	3.2	NA	NA	NS	NS	3.0	2.6	NA	NS	9.3	10.7	12.1	NA	NA	6.1	13.3	NA	NA
TPH	mg/L	NA	NA	NA	ND	NS	NS	NA	NA	NA	NS	NA	NA	NA	ND	NA	7.4	NA	NA	2.3
INORGANICS																				
Phenol	mg/L	<0.05	NA	NA	NA	NS	NS	<0.05	NA	NA	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	mg/L	22.0	NA	NA	NA	NS	NS	18.7	NA	NA	NS	0.6	NA	NA	NA	NA	12.6	NA	NA	NA
Nitrate	mg/L	ND	NA	NA	NA	NS	NS	ND	NA	NA	NS	ND	NA	NA	NA	NA	ND	NA	NA	NA
Chloride	mg/L	12.3	NA	NA	NA	NS	NS	12.4	NA	NA	NS	11.2	NA	NA	NA	NA	27.8	NA	NA	NA
Iron	mg/L	0.8	NA	NA	NA	NS	NS	0.7	NA	NA	NS	3.4	NA	NA	NA	NA	5.8	NA	NA	NA
Manganese	mg/L	0.042	NA	NA	NA	NS	NS	0.036	NA	NA	NS	0.095	NA	NA	NA	NA	0.082	NA	NA	NA
Sodium	mg/L	ND	NA	NA	NA	NS	NS	10.8	NA	NA	NS	7.8	NA	NA	NA	NA	18.2	NA	NA	NA
Lead	mg/L	ND	NA	NA	NA	NS	NS	0.008	NA	NA	NS	0.003	NA	NA	NA	NA	ND	NA	NA	NA
Zinc	mg/L	0.009	NA	NA	NA	NS	NS	0.120	NA	NA	NS	0.002	NA	NA	NA	NA	0.002	NA	NA	NA
Vanadium	mg/L	0.002	NA	NA	NA	NS	NS	ND	NA	NA	NS	ND	NA	NA	NA	NA	ND	NA	NA	NA
TDS	mg/L	NA	NA	NA	110	NS	NS	NA	NA	NA	NS	NA	NA	NA	140	126	NA	NA	NA	260

NS = Not Sampled  
NA = Not Analyzed  
NR = Not Reported  
s = Secondary MCL  
MCL = Maximum Contaminant Level

TDS = Total Dissolved Solids  
VOCs = Volatile Organic Compounds  
TOC = Total Organic Compounds  
TOX = Total Organic Halides  
TPH = Total Petroleum Hydrocarbons

(a) = Water and Fish Ingestion  
\* = Exceeds the Federal MCL  
\*\* = Exceeds Ambient Water Quality Criteria

**GROUND WATER SCREEN RESULTS**

**JUNE, 1993**

**TABLE 2**  
**FIELD GROUND-WATER SCREEN RESULTS, June 1993**  
**POL Area**  
**Former Myrtle Beach AFB, South Carolina**

PARAMETER	METHOD	SAMPLE NUMBER				
		SS03GW01	SS03GW02	SS03GW03	SS03GW04	SS03GW05
Benzene ( $\mu\text{g/L}$ )	EPA 602M	26	80	<1	1.7	<1
Ethylbenzene ( $\mu\text{g/L}$ )	EPA 602M	15	6.7	<1	2.7	<1
Toluene ( $\mu\text{g/L}$ )	EPA 602M	48	12	<1	<1	<1
Xylenes, total <sup>(a)</sup> ( $\mu\text{g/L}$ )	EPA 602M	735	977	<1	7.5	1.5
Total FID Volatiles ( $\mu\text{g/L}$ )	EPA 602M	2208	2714	<10	80	45

PARAMETER	METHOD	SAMPLE NUMBER			
		SS03GW06	SS03GW07	SS03GW08	SS03GW09
Benzene ( $\mu\text{g/L}$ )	EPA 602M	7673	345	382	73
Ethylbenzene ( $\mu\text{g/L}$ )	EPA 602M	10,810	597	21	22
Toluene ( $\mu\text{g/L}$ )	EPA 602M	839	324	40	82
Xylenes, total <sup>(a)</sup> ( $\mu\text{g/L}$ )	EPA 602M	5327	2309	509	851
Total FID Volatiles ( $\mu\text{g/L}$ )	EPA 602M	322,000 <sup>(b)</sup>	25,110	3734	8077

(a) Total xylenes includes ortho, meta and para xylenes.

(b) Concentration may be higher than reported due to saturation of the detector.

**TABLE 3**  
**GROUND-WATER SCREEN RESULTS, June 1993**  
**Law Environmental National Labs**  
**POL Area**  
**Former Myrtle Beach AFB, South Carolina**

PARAMETER	METHOD	SAMPLE NUMBER	
		SS03GW02	SS03GW04
Benzene ( $\mu\text{g/L}$ )	SW 8020	330	6.8
Ethylbenzene ( $\mu\text{g/L}$ )	SW 8020	35	1.7
Toluene ( $\mu\text{g/L}$ )	SW 8020	<25	4.0
Xylenes ( $\mu\text{g/L}$ )	SW 8020	2300	12
Surrogates:			
fluorobenzene (%)	SW 8020	109	107
4-chlorotoluene (%)	SW 8020	112	109

Positive results listed only.

**SOIL BORING SAMPLES ANALYTICAL RESULTS**

**APRIL 1994**



SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	SS03SB0156 Sample Date: 03/22/94 Sample Depth: 4'-6'	SS03SB0288 03/11/94 6'-8'	SS03SB0388 03/11/94 6'-8'
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	MG/KG	0.0005	<14P JD	0.0087P	<0.0005P
ETHYLBENZENE	MG/KG	0.0005	260P JD	0.01P	0.0024P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	920P JD*	0.062P	0.028P
TOLUENE	MG/KG	0.0005	190P JD	0.0038P	0.0009P
<u>Surrogates:</u>					
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	143P	113P	113P / 113 / 153
FLUOROBENZENE (77 - 125 % R)	%	1.0	93P	93P	93P / 93 / 98
<u>Dilution Factor:</u>					
	--	--	* 55000 / 28000	5	1
<u>SW8310/PAHs:</u>					
ACENAPHTHENE	MG/KG	0.02	<0.022	<0.024	<0.024
ANTHRACENE	MG/KG	0.027	<0.03	<0.032	<0.032
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.022	<0.024	<0.024
CHRYSENE	MG/KG	0.2	<0.022	<0.024	<0.024
FLUORANTHENE	MG/KG	0.2	<0.022	<0.024	<0.024
NAPHTHALENE	MG/KG	0.2	28 *	<0.024	<0.024
PHENANTHRENE	MG/KG	0.017	<0.019	<0.02	<0.02
PYRENE	MG/KG	0.017	<0.019	<0.02	<0.02
<u>Surrogates:</u>					
CARBAZOLE (37 - 153 % R)	%	1.0	110	108	87
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	1230	52	48
<u>Dilution Factor:</u>					
	--	--	* 41	1	1
<u>D2216/Soil Moisture:</u>					
MOISTURE	%	--	11	15	17
<u>M8015/TPH - Semi-Volatiles (c):</u>					
DIESEL COMPONENTS	MG/KG	1.0	20000 (JP-4)	5000 (JP-4)	<11
<u>Surrogate:</u>					
o-TERPHEYL (80 - 149 % R)	%	1.0	0	108	90
<u>Dilution Factor:</u>					
	--	--	1000	51	1

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

TABLE 4

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/11/94 Sample Depth: 0-2'	SS03SB0546 03/11/94 4-6'	SS03SB06C 03/21/94 4-6'
<b>SW8020/Aromatic Volatiles (b):</b>					
BENZENE	MG/KG	0.0005	<0.0005P	<0.013P	0.009P
ETHYLBENZENE	MG/KG	0.0005	<0.0005P	<0.0005P	0.0055P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	0.0013P	4.7P JH*	0.044P
TOLUENE	MG/KG	0.0005	0.003P	0.17P*	<0.0025P
Surrogates:					
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	90P	148P	108P
FLUOROBENZENE (77 - 125 % R)	%	1.0	120P	88P	100P
Dilution Factor:					
	--	--	1	*100 / 25	5
<b>SW8310/PAHs:</b>					
ACENAPHTHENE	MG/KG	0.02	<0.027	<0.023	<0.023
ANTHRACENE	MG/KG	0.027	<0.036	<0.031	<0.031
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.027	<0.023	<0.023
CHRYSENE	MG/KG	0.2	<0.027	<0.023	<0.023
FLUORANTHENE	MG/KG	0.2	<0.027	<0.023	<0.023
NAPHTHALENE	MG/KG	0.2	<0.027	<0.023	<0.023
PHENANTHRENE	MG/KG	0.017	<0.022	<0.019	0.042
PYRENE	MG/KG	0.017	<0.022	<0.019	<0.019
Surrogates:					
CARBAZOLE (37 - 153 % R)	%	1.0	84	95	101
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	48	305	72
Dilution Factor:					
	--	--	1	1	1
<b>D2216/Soil Moisture:</b>					
MOISTURE	%	--	10	15	13
<b>M8015/TPH - Semi-Volatiles (c):</b>					
DIESEL COMPONENTS	MG/KG	1.0	<12	5100 (JP-4)	11 (JP-4)
Surrogate:					
o-TERPHEHYL (80 - 149 % R)	%	1.0	94	112	103
Dilution Factor:					
	--	--	1	51	1

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon GC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

TABLE 4

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/12/94 Sample Depth: 4-6'	SS03SB088 03/12/94 2-4'	SS03SB09C 03/12/94 4-6'
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	MG/KG	0.0005	<5.0P JD	0.88P JD	0.23P
ETHYLBENZENE	MG/KG	0.0005	18P JD	<0.5P JD*	2.0P JD*
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	54P JD	23P JD*	6.4P JD*
TOLUENE	MG/KG	0.0005	<5.0P JD	<0.5P JD	<0.025P
<u>Surrogates:</u>					
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	108P	123P	123P
FLUOROBENZENE (77 - 125 % R)	%	1.0	95P	93P	95P
<u>Dilution Factor:</u>					
	--	--	5000	*200 / 1000	*250 / 50
<u>SW8310/PAHs:</u>					
ACENAPHTHENE	MG/KG	0.02	<0.024	<0.025	<0.026
ANTHRACENE	MG/KG	0.027	<0.032	<0.033	<0.034
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.024	<0.025	<0.026
CHRYSENE	MG/KG	0.2	<0.024	<0.025	<0.026
FLUORANTHENE	MG/KG	0.2	<0.024	<0.025	<0.026
NAPHTHALENE	MG/KG	0.2	6.8 *	2.0	0.95
PHENANTHRENE	MG/KG	0.017	<0.02	<0.02	<0.021
PYRENE	MG/KG	0.017	<0.02	<0.02	<0.021
<u>Surrogates:</u>					
CARBAZOLE (37 - 153 % R)	%	1.0	104	98	98
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	300	240	114
<u>Dilution Factor:</u>					
	--	--	*11	1	1
<u>D2210/Soil Moisture:</u>					
MOISTURE	%	--	17	20	21
<u>M8015/TPH - Semi-Volatiles (c):</u>					
DIESEL COMPONENTS	MG/KG	1.0	3300 (P-4)	1800 (P-4)	1800 (P-4)
<u>Surrogate:</u>					
o-TERPHEYL (80 - 149 % R)	%	1.0	138	120	70
<u>Dilution Factor:</u>					
	--	--	51	51	51

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

TABLE 4

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/12/94 Sample Depth: 4'-6'	SS03SB11B 03/12/94 2'-4'	Sample SS03SB12C 03/12/94 4'-6'	Duplicate SS03SBDUP1 03/12/94 4'-6'
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	MG/KG	0.0005	<0.13P JD	<0.0005P	1.1P JD	2.7P JD
ETHYLBENZENE	MG/KG	0.0005	5.7P JD	<0.0005P	10P JD	21P JD
M/P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	10P JD	<0.001P	30P JD	66P JD*
TOLUENE	MG/KG	0.0005	<0.13P JD	<0.0005P	<0.5P JD	<10P JD
<u>Surrogates:</u>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	135P	95P	123P	103P
FLUOROBENZENE (77 - 125 % R)	%	1.0	93P	98P	95P	95P
<u>Dilution Factor:</u>						
	--	--	500	1	1000	* 20000 / 1000
<u>SW8310/PAHs:</u>						
ACENAPHTHENE	MG/KG	0.02	<0.025	<0.025	<0.024	<0.023
ANTHRACENE	MG/KG	0.027	<0.033	<0.033	<0.032	<0.031
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.025	<0.025	<0.024	<0.023
CHRYSENE	MG/KG	0.2	<0.025	<0.025	<0.024	<0.023
FLUORANTHENE	MG/KG	0.2	<0.025	<0.025	<0.024	<0.023
NAPHTHALENE	MG/KG	0.2	0.36	<0.025	3.8 J*	1.4 J
PHENANTHRENE	MG/KG	0.017	<0.021	<0.02	<0.02	<0.019
PYRENE	MG/KG	0.017	<0.021	<0.02	<0.02	<0.019
<u>Surrogates:</u>						
CARBAZOLE (37 - 153 % R)	%	1.0	91	88	101	93
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	115	66	270	170
<u>Dilution Factor:</u>						
	--	--	1	1	*11	1
<u>D2216/Soil Moisture:</u>						
MOISTURE	%	--	21	19	17	15
<u>M8015/TPH - Semi-Volatiles (c):</u>						
DIESEL COMPONENTS	MG/KG	1.0	390 (JP-5)	<12	2900 (JP-4)	2100 (JP-4)
<u>Surrogate:</u>						
o-TERPHEYL (60 - 149 % R)	%	1.0	76	68	0	87
<u>Dilution Factor:</u>						
	--	--	11	1	51	51

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	SS03SB13C Sample Date: 03/21/94 Sample Depth: 4'-6'	SS03SB14B 03/21/94 2'-4'	Sample SS03SB15C 03/21/94 4'-6'	Duplicate SS03SB15C 03/21/94 4'-6'
<b>SW8020/Aromatic Volatiles (b):</b>						
BENZENE	MG/KG	0.0005	0.22P JD	0.0073P	<5.0P JD	<0.13P JD
ETHYLBENZENE	MG/KG	0.0005	1.5P JD	0.025P	51P JD	29P JD
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	4.3P JD	0.023P	150P JD	89P JD
TOLUENE	MG/KG	0.0005	<0.1P JD	0.01P	<5.0P JD	<2.5P JD
<b>Surrogates:</b>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	133P	118P	113P	113P
FLUOROBENZENE (77 - 125 % R)	%	1.0	100P	100P	98P	98P
<b>Dilution Factor:</b>						
	--	--	200	5	10000	5000
<b>SW8310/PAHs:</b>						
ACENAPHTHENE	MG/KG	0.02	<0.024	<0.024	<0.023	<0.024
ANTHRACENE	MG/KG	0.027	<0.031	<0.032	<0.03	<0.032
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.024	<0.024	<0.023	<0.024
CHRYSENE	MG/KG	0.2	<0.024	<0.024	<0.023	<0.024
FLUORANTHENE	MG/KG	0.2	<0.024	<0.024	<0.023	<0.024
NAPHTHALENE	MG/KG	0.2	1.7	<0.024	9.8 *	<0.024
PHENANTHRENE	MG/KG	0.017	<0.02	<0.02	<0.019	6.7 *
PYRENE	MG/KG	0.017	<0.02	<0.02	<0.019	<0.02
<b>Surrogates:</b>						
CARBAZOLE (37 - 153 % R)	%	1.0	101	95	102	100
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	183	72	551	422
<b>Dilution Factor:</b>						
	--	--	1	1	*6	*6
<b>D2210/Soil Moisture:</b>						
MOISTURE	%	--	18	18	13	15
<b>M8015/TPH - Semi-Volatiles (c):</b>						
DIESEL COMPONENTS	MG/KG	1.0	750 (P-5)	<12	2800 J (P-5)	4800 J (P-4)
<b>Surrogate:</b>						
o-TERPHEHYL (80 - 149 % R)	%	1.0	112	96	120	0
<b>Dilution Factor:</b>						
	--	--	21	1	51	51

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTIFICATION LIMIT (a)	SS03SB16C Sample Date: 03/24/94 Sample Depth: 4'-6'	SS03SB17B 03/24/94 2'-4'	SS03SB18B 03/24/94 2'-4'	SS03SB19B 03/24/94 2'-4'
<b>SW8020/Aromatic Volatiles (b):</b>						
BENZENE	MG/KG	0.0005	<0.013P	<0.0005P	0.0036P JH	0.00094P
ETHYLBENZENE	MG/KG	0.0005	0.082P	<0.0005P	0.0023P JH	<0.0005P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	0.58P JH	<0.001P	0.0019P JH	0.0057P
TOLUENE	MG/KG	0.0005	0.11P	<0.0005P	0.009P JH	0.0015P
<b>Surrogates:</b>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	150P	103P	128P	113P
FLUOROBENZENE (77 - 125 % R)	%	1.0	90P	98P	138P	103P
<b>Dilution Factor:</b>						
	--	--	25	1	1	1
<b>SW8310/PAHs:</b>						
ACENAPHTHENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.022
ANTHRACENE	MG/KG	0.027	<0.032	<0.032	<0.032	<0.03
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.022
CHRYSENE	MG/KG	0.2	<0.024	<0.024	<0.024	<0.022
FLUORANTHENE	MG/KG	0.2	<0.024	<0.024	<0.024	<0.022
NAPHTHALENE	MG/KG	0.2	0.039	<0.024	<0.024	<0.022
PHENANTHRENE	MG/KG	0.017	<0.02	<0.02	<0.02	<0.022
PYRENE	MG/KG	0.017	<0.02	<0.02	<0.02	<0.018
<b>Surrogates:</b>						
CARBAZOLE (37 - 153 % R)	%	1.0	99	98	100	92
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	73	68	68	83
<b>Dilution Factor:</b>						
	--	--	1	1	1	1
<b>D2216/Soil Moisture:</b>						
MOISTURE	%	--	17	15	15	11
<b>M8015/TPH - Semi-Volatiles (c):</b>						
DIESEL COMPONENTS	MG/KG	1.0	290 (JP-5)	<12	<12	<11
<b>Surrogate:</b>						
o-TERPHENYL (80 - 149 % R)	%	1.0	100	84	94	93
<b>Dilution Factor:</b>						
	--	--	11	1	1	1

(a) - Detection/Quantitation limits listed are "Ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	SS03SB20C Sample Date: 03/24/94 Sample Depth: 4'-8'	Background SS03SB21B 03/24/94 2'-4'	SS03SB2268 03/26/94 8'-8'
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	MG/KG	0.0005	<0.025P	<0.0005P	0.019P
ETHYLBENZENE	MG/KG	0.0005	0.24P	<0.0005P	0.1P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	0.34P	<0.001P	0.43P
TOLUENE	MG/KG	0.0005	<0.025P	<0.0005P	0.071P
<u>Surrogates:</u>					
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	108P	100P	118P
FLUOROBENZENE (77 - 125 % R)	%	1.0	98P	100P	98P
<u>Dilution Factor:</u>					
	--	--	50	1	25
<u>SW8310/PAHs:</u>					
ACENAPHTHENE	MG/KG	0.02	0.025	<0.024	<0.023
ANTHRACENE	MG/KG	0.027	0.035	<0.032	<0.031
BENZO(a)ANTHRACENE	MG/KG	0.02	0.029	<0.024	<0.023
CHRYSENE	MG/KG	0.2	0.028	<0.024	<0.023
FLUORANTHENE	MG/KG	0.2	0.17	<0.024	<0.023
NAPHTHALENE	MG/KG	0.2	0.036	<0.024	<0.023
PHENANTHRENE	MG/KG	0.017	0.14	<0.02	<0.02
PYRENE	MG/KG	0.017	0.071	<0.02	<0.02
<u>Surrogates:</u>					
CARBAZOLE (37 - 153 % R)	%	1.0	91	93	100
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	71	62	68
<u>Dilution Factor:</u>					
	--	--	1	1	1
<u>D2210/Soil Moisture:</u>					
MOISTURE	%	--	15	17	15
<u>M8015/TPH - Semi-Volatiles (c):</u>					
DIESEL COMPONENTS	MG/KG	1.0	40 (JP-4)	<12	<12
<u>Surrogate:</u>					
o-TERPHENYL (90 - 149 % R)	%	1.0	84	88	67
<u>Dilution Factor:</u>					
	--	--	1	1	1

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/10/94 Sample Depth: 4 - 6'	Background SS03SO0146 03/10/94 4 - 6'	SS03SO0246 03/10/94 4 - 6'	SS03SO0346 03/12/94 4 - 6'	Sample SS03SO0446 03/11/94 4 - 6'	Duplicate SS03SO0446 03/11/94 4 - 6'
<u>SW8020/Aromatic Volatiles (b):</u>								
BENZENE	MG/KG	0.0005		<0.0005P	0.0006P	0.0022P	0.07P JD	0.066P J
ETHYLBENZENE	MG/KG	0.0005		<0.0005P	<0.0005P	<0.0005P	1.5P JD	<0.025P J
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001		0.0011P	<0.001P	<0.001P	7.7P JD	0.24P J
TOLUENE	MG/KG	0.0005		0.0015P	0.0075P	0.0017P	1.7P JD	0.11P J
<u>Surrogates:</u>								
4-CHLOROTOLUENE (70 - 124 % R)	%	1.0		98P	100P	100P	75P	105P
FLUOROBENZENE (77 - 125 % R)	%	1.0		108P	105P	100P	90P	98P
<u>Dilution Factor:</u>								
	--	--		1	1	1	1000	50
<u>SW8310/PAHs:</u>								
BENZO(a)PYRENE	MG/KG	0.02		<0.023	<0.02	<0.028	<0.026	<0.026
NAPHTHALENE	MG/KG	0.02		<0.023	<0.02	<0.028	13 J	2.5 J
<u>Surrogates:</u>								
CARBAZOLE (37 - 153 % R)	%	1.0		91	99	89	108	92
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0		57	59	61	470	200
<u>Dilution Factor:</u>								
	--	--		1	1	1	1	1
<u>D2216/Soil Moisture:</u>								
MOISTURE	%	--		15	20	29	29	10
<u>M8015/TPH - Volatiles (c):</u>								
DIESEL COMPONENTS	MG/KG	10		<12	<12	<13	2900 (JP-4)	2100 (JP-4)
<u>Surrogate:</u>								
o-Terphenyl (80 - 149 % R)	%	1.0		89	94	85	133	104
<u>Dilution Factor:</u>								
	--	--		1	1	1	51	51

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.  
(b) - Results for this method are listed as: Primary/first column/second column.  
(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.  
P - Primary result.  
\* - Dilution specific to compound indicated.  
J - Estimated quantitation based upon QC data.  
JD - Estimated quantitation based on dilution.  
NA - Not analyzed.  
TPH - Total Petroleum Hydrocarbons.



SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/21/94 Sample Depth: 4-6'	SS03SO0548 03/12/94 7-9'	SS03SO0879 03/13/94 8-10'	SS03SO07810 03/22/94 6-8'
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	MG/KG	0.0005	6.5P JD	<13P JD	<0.0005P	<0.0005P
ETHYLBENZENE	MG/KG	0.0005	11P JD	91P JD	<0.0005P	<0.0005P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	48P JD	240P JD*	<0.001P	<0.001P
TOLUENE	MG/KG	0.0005	33P JD	<25P JD	0.0032P	0.0017P
<u>Surrogates:</u>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	120P	105P	98P	103P
FLUOROBENZENE (77 - 125 % R)	%	1.0	108P	95P	108P	95P
<u>Dilution Factor:</u>	--	--	2500	*50000 / 5000	1	1
<u>SW8310/PAHs:</u>						
BENZO(a)PYRENE	MG/KG	0.02	0.03	<0.024	<0.026	<0.03
NAPHTHALENE	MG/KG	0.02	7.2 *	4.6 *	0.05	<0.03
<u>Surrogates:</u>						
CARBAZOLE (37 - 153 % R)	%	1.0	102	93	87	74
DECAFLUOROBIPHENYL (0 - 121 % R)	%	1.0	511	400	60	23
<u>Dilution Factor:</u>	--	--	*6	*11	1	1
<u>D2219/Soil Moisture:</u>						
MOISTURE	%	--	17	15	22	34
<u>M8015/TPH - Volatiles (c):</u>						
DIESEL COMPONENTS	MG/KG	10	7700 (JP-4)	6800 (JP-4)	<12	<15
<u>Surrogate:</u>						
o-Terphenyl (60 - 149 % R)	%	1.0	112	123	81	73
<u>Dilution Factor:</u>	--	--	51	51	1	1

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

SOIL BORING SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION	SS03SO0968 Sample Date: 03/22/94 Sample Depth: 6-8'	SS03SO1079 03/13/94 7-9'	SS03SO111012 03/26/94 10-12'
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	MG/KG	0.0005	<0.0005P	<0.0005P	<0.0005P
ETHYLBENZENE	MG/KG	0.0005	<0.0005P	<0.0005P	<0.0005P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	0.0016P	<0.001P	<0.001P
TOLUENE	MG/KG	0.0005	0.002P	0.004P	0.0029P
Surrogates:					
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	103P	98P	103P
FLUOROBENZENE (77 - 125 % R)	%	1.0	100P	108P	108P
Dilution Factor:	--	--	1	1	1
<u>SW8310/PAHs:</u>					
BENZO(a)PYRENE	MG/KG	0.02	<0.027	<0.027	<0.028
NAPHTHALENE	MG/KG	0.02	<0.027	<0.027	<0.028
Surrogates:					
CARBAZOLE (37 - 153 % R)	%	1.0	98	98	93
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	63	60	52
Dilution Factor:	--	--	1	1	1
<u>D2216/Soil Moisture:</u>					
MOISTURE	%	--	23	27	28
<u>M8015/TPH - Volatiles (c):</u>					
DIESEL COMPONENTS	MG/KG	10	<13	<13	<14
Surrogate:					
o-Terphenyl (60 - 149 % R)	%	1.0	77	69	75
Dilution Factor:	--	--	1	1	1

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JD - Estimated quantitation based on dilution.

NA - Not analyzed.

TPH - Total Petroleum Hydrocarbons.

**HAND AUGER SAMPLES ANALYTICAL RESULTS**

**APRIL, 1994**

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION	Background SS03HA0134 Sample Date: 03/15/94 Sample Depth: 3-4'	SS03HA0256 03/15/94 5-6'	SS03HA0345 03/21/94 4-5'	SS03HA0445 03/21/94 4-5'
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	MG/KG	0.0005	<0.0005	<0.0005P	<0.0025P	0.00057P
ETHYLBENZENE	MG/KG	0.0005	<0.0005	<0.0005P	<0.0025P	0.0017P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	<0.001	<0.001P	0.29P	<0.001P
TOLUENE	MG/KG	0.0005	<0.0005	0.0011P	<0.025P	0.0057P
<u>Surrogates:</u>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	93	110P	103P	103P
FLUOROBENZENE (77 - 128 % R)	%	1.0	110	85P	100P	103P
<u>Dilution Factor:</u>						
	--	--	1	1	5	1
<u>SW8310/PAHs:</u>						
ACENAPHTHENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
BENZO(a)PYRENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
BENZO(g,h,i)PERYLENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
BENZO(k)FLUORANTHENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
CHRYSENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
FLUORANTHENE	MG/KG	0.02	<0.026	<0.025	<0.024	<0.023
FLUORENE	MG/KG	0.017	<0.021	<0.021	<0.02	<0.019
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	<0.038	<0.037	<0.036	<0.035
NAPHTHALENE	MG/KG	0.02	<0.026	0.05	<0.024	<0.023
PHENANTHRENE	MG/KG	0.017	<0.021	<0.021	<0.02	<0.019
PYRENE	MG/KG	0.017	<0.021	<0.021	<0.02	<0.019
<u>Surrogates:</u>						
CARBAZOLE (37 - 153 % R)	%	1.0	94	95	95	99
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	48	59	51	57
<u>Dilution Factor:</u>						
	--	--	1	1	1	1

**HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994**  
**LAW ENVIRONMENTAL NATIONAL LABS**  
**POL Area**  
**Former Myrtle Beach AFB, South Carolina**

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Background			
			SS03HA0134 Sample Date: 03/15/94 Sample Depth: 3-4'	SS03HA0256 03/15/94 5-6'	SS03HA0345 03/21/94 4-5'	SS03HA0445 03/21/94 4-5'
<u>D2216/Soil Moisture:</u>						
<u>MOISTURE</u>	MG/KG	--	22	19	15	15
<u>M8015/Semi-Volatiles (c):</u>						
<u>DIESEL COMPONENTS</u>	MG/KG	10	<13	<12	<12	<12
<u>Surrogate:</u>						
o-TERPHENYL (80 - 149 % R)	%	1.0	71	78	88	83
<u>Dilution Factor:</u>	--	--	1	1	1	1

(a) — Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) — Results for this method are listed as: Primary/first column/second column.

(c) — Results are quantitated as gasoline or diesel but may be identified as another fuel.

P — Primary result.

— — Not analyzed.

† — Dilution specific to compound indicated.

J — Estimated quantitation based on QC data.

JD — Estimated quantitation based on dilution.

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/21/94 Sample Depth: 4-5'	SS03HA0545	SS03HA0658 03/21/94 5-6'	Sample SS03HA0756 03/21/94 5-6'	Duplicate SS03HADUP3 03/21/94 5-6'
<u>SW8020/Aromatic Volatiles (b):</u>							
BENZENE	MG/KG	0.0005		<0.0005P	<0.1P	0.011P	0.0067P
ETHYLBENZENE	MG/KG	0.0005		<0.0005P	0.59P JD*	0.06P J	0.034P J
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001		<0.001P	2.9P JD*	0.077P	0.047P
TOLUENE	MG/KG	0.0005		0.0072P	0.49P JD*	0.0062P	0.0077P
<u>Surrogates:</u>							
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0		98P	125P	113P	125P
FLUOROBENZENE (77 - 125 % R)	%	1.0		103P	93P	98P	95P
<u>Dilution Factor:</u>							
	--	--	1		* 200/100	5	5
<u>SW8310/PAHs:</u>							
ACENAPHTHENE	MG/KG	0.02		<0.024	<0.023	<0.025	<0.024
BENZO(a)ANTHRACENE	MG/KG	0.02		<0.024	0.027	0.031	<0.024
BENZO(a)PYRENE	MG/KG	0.02		<0.024	0.025	<0.025	<0.024
BENZO(b)FLUORANTHENE	MG/KG	0.02		<0.024	<0.023	0.046	0.027
BENZO(g,h,i)PERYLENE	MG/KG	0.02		<0.024	<0.023	<0.025	<0.024
BENZO(k)FLUORANTHENE	MG/KG	0.02		<0.024	<0.023	<0.025	<0.024
CHRYSENE	MG/KG	0.02		<0.024	<0.023	0.029	<0.024
FLUORANTHENE	MG/KG	0.02		<0.024	<0.023	0.093	0.085
FLUORENE	MG/KG	0.017		<0.02	0.059	<0.021	<0.02
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03		<0.036	<0.036	<0.037	<0.036
NAPHTHALENE	MG/KG	0.02		<0.024	0.71	<0.025	<0.024
PHENANTHRENE	MG/KG	0.017		<0.02	<0.02	0.058	<0.02
PYRENE	MG/KG	0.017		<0.02	0.067	0.052	0.02
<u>Surrogates:</u>							
CARBAZOLE (37 - 153 % R)	%	1.0		89	99	91	95
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0		57	111	61	56
<u>Dilution Factor:</u>							
	--	--	1		1	1	1

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/21/94 Sample Depth: 4 - 5'	SS03HA0545 03/21/94 5-6'	SS03HA0656 03/21/94 5-6'	Sample SS03HA0756 03/21/94 5-6'	Duplicate SS03HADUP3 03/21/94 5-6'
<u>D2210/Soil Moisture:</u> MOISTURE	MG/KG	--	15	15	19	17	
<u>M8015/Semi-Volatiles (c):</u> DIESEL COMPONENTS	MG/KG	10	<12	310 (JP-5)	<12	<12	
Surrogate: o-TERPHENYL (60 - 149 % R)	%	1.0	74	94	98	92	
<u>Dilution Factor:</u>	--	--	1	11	1	1	

(a) -- Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) -- Results for this method are listed as: Primary/first column/second column.

(c) -- Results are quantitated as gasoline or diesel but may be identified as another fuel.

P -- Primary result.

-- Not analyzed.

\* -- Dilution specific to compound indicated.

J -- Estimated quantitation based on QC data.

JD -- Estimated quantitation based on dilution.



TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/15/94 Sample Depth: 4-5'	SS03HA0945 03/15/94 4-5'	Sample SS03HA1045 03/15/94 4-5'	Duplicate SS03HADUP2 03/15/94 4-5'
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	MG/KG	0.0005	11P JD	40P JD	<0.025P	<0.013P
ETHYLBENZENE	MG/KG	0.0005	19P JD	69P JD	0.52P J	0.13P J
M,P -XYLENE (SUM OF ISOMERS)	MG/KG	0.001	81P JD	280P JD	0.75P J	0.23P J
TOLUENE	MG/KG	0.0005	55P JD	210P JD	0.097P	0.03P
<u>Surrogates:</u>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	140P	138P	113P	125P
FLUOROBENZENE (77 - 125 % R)	%	1.0	93P	93P	89P	93P
<u>Dilution Factor:</u>						
	--	--	5000	25000	50	25
<u>SW8310/PAHs:</u>						
ACENAPHTHENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.024
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.024	0.28	<0.024	<0.024
BENZO(a)PYRENE	MG/KG	0.02	0.069	0.16	<0.024	<0.024
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.024
BENZO(g,h,i)PERYLENE	MG/KG	0.02	0.032	0.067	<0.024	<0.024
BENZO(k)FLUORANTHENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.024
CHRYSENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.024
FLUORANTHENE	MG/KG	0.02	<0.024	<0.024	<0.024	<0.024
FLUORENE	MG/KG	0.017	<0.02	<0.02	<0.024 J	0.089 J
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	0.05	0.078	<0.02	<0.02
NAPHTHALENE	MG/KG	0.02	9.2*	39*	<0.036	<0.036
PHENANTHRENE	MG/KG	0.017	<0.02	<0.02	0.1	0.092
PYRENE	MG/KG	0.017	<0.02	<0.02	<0.02	<0.02
				<0.02	<0.02	0.041
<u>Surrogates:</u>						
CARBAZOLE (37 - 153 % R)	%	1.0	108	111	84	96
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	735	2500	67	79
<u>Dilution Factor:</u>						
	--	--	* 11	* 21	1	1

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/15/94 Sample Depth: 4-5'	SS03HA0845	SS03HA0945 03/15/94 4-5'	Sample SS03HA1045 03/15/94 4-5'	Duplicate SS03HADUP2 03/15/94 4-5'
<u>D2216/Soil Moisture:</u> MOISTURE	MG/KG	--	18	17	15	17	
<u>M8015/Semi-Volatiles (c):</u> DIESEL COMPONENTS	MG/KG	10	4100 (JP -5) 5700 JD* (Gasoline)	19000 J (JP -4)	<23	<24	
Surrogate: o-TERPHENYL (80 - 149 % R)	%	1.0	92	0	88	73	
<u>Dilution Factor:</u>	--	--	1 / 1000*	101	2	2	

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

-- Not analyzed.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based on QC data.

JD - Estimated quantitation based on dilution.

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/15/94 Sample Depth: 4-5'	SS03HA1145 03/15/94 5-6'	SS03HA1258 03/15/94 5-6'	SS03HA1358 03/15/94 5-6'	SS03HA1445 03/15/94 4-5'
<b>SW8020/Aromatic Volatiles (b):</b>							
BENZENE	MG/KG	0.0005	<0.0005P				<0.0005P
ETHYLBENZENE	MG/KG	0.0005	0.0014P				0.014P
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	0.0017P				0.0094P
TOLUENE	MG/KG	0.0005	0.0035P				0.0035P
<b>Surrogates:</b>							
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	105P				110P
FLUOROBENZENE (77 - 125 % R)	%	1.0	93P				93P
<b>Dilution Factor:</b>							
	--	--	1	100	1	1	1
<b>SW8310/PAHs:</b>							
ACENAPHTHENE	MG/KG	0.02	<0.024				0.039
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.024				0.18
BENZO(a)PYRENE	MG/KG	0.02	<0.024				0.26
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.024				0.59
BENZO(g,h,i)PERYLENE	MG/KG	0.02	<0.024				0.17
BENZO(k)FLUORANTHENE	MG/KG	0.02	<0.024				0.13
CHRYSENE	MG/KG	0.02	<0.024				0.2
FLUORANTHENE	MG/KG	0.02	<0.024				0.32
FLUORENE	MG/KG	0.017	<0.02				<0.019
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	<0.036				0.23
NAPHTHALENE	MG/KG	0.02	<0.024				<0.023
PHENANTHRENE	MG/KG	0.017	<0.02				0.02
PYRENE	MG/KG	0.017	<0.02				0.27
<b>Surrogates:</b>							
CARBAZOLE (37 - 153 % R)	%	1.0	85				93
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	59				79
<b>Dilution Factor:</b>							
	--	--	1	1	1	1	1

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/15/94 Sample Depth: 4-5'	SS03HA1145	SS03HA1256 03/15/94 5-6'	SS03HA1356 03/15/94 5-6'	SS03HA1445 03/15/94 4-5'
<u>D2216/Soil Moisture:</u> MOISTURE	MG/KG	--	16	20	16	15	
<u>M8015/Semi-Volatiles (c):</u> DIESEL COMPONENTS	MG/KG	10	<12	220 (JP-4)	<12	<12	
<u>Surrogate:</u> o-TERPHENYL (60 - 149 % R)	%	1.0	75	60	97	73	
<u>Dilution Factor:</u>	--	--	1	11	1	1	

- (a) - Detection/Quantitation limits listed are "Ideal". Sample specific limits may vary by sample volume and/or dilution factors.  
 (b) - Results for this method are listed as: Primary/first column/second column.  
 (c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.  
 P - Primary result.  
 -- - Not analyzed.  
 \* - Dilution specific to compound indicated.  
 J - Estimated quantitation based on QC data.  
 JD - Estimated quantitation based on dilution.

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/15/94 Sample Depth: 5-6'	SS03HA1556	SS03HA1656 03/15/94 5-6'	SS03HA1756 03/15/94 5-6'	SS03HA1845 03/14/94 4-5'
<b>SW8020/Aromatic Volatiles (b):</b>							
BENZENE	MG/KG	0.0005	<2.5P JD	1.8P JD	0.28P JD	0.0011P	
ETHYLBENZENE	MG/KG	0.0005	71P JD	22P JD*	3.6P JD	<0.0005P	
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	87P JD	20P JD	2.6P JD	0.0013P	
TOLUENE	MG/KG	0.0005	<2.5P JD	<0.25P JD	<0.1P JD	0.0095P	
<b>Surrogates:</b>							
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	150P	195P	128P	98P	
FLUOROBENZENE (77 - 125 % R)	%	1.0	83P	85P	92P	105P	
<b>Dilution Factor:</b>							
	--	--	5000	* 5000/500	200	1	
<b>SW8310/PAHs:</b>							
ACENAPHTHENE	MG/KG	0.02	0.54	<0.024	<0.021	<0.024	
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.024	<0.024	<0.021	<0.024	
BENZO(a)PYRENE	MG/KG	0.02	0.043	<0.024	<0.021	<0.024	
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.024	<0.024	<0.021	<0.024	
BENZO(g,h,i)PERYLENE	MG/KG	0.02	0.029	<0.024	<0.021	<0.024	
BENZO(k)FLUORANTHENE	MG/KG	0.02	<0.024	<0.024	<0.021	<0.024	
CHRYSENE	MG/KG	0.02	<0.024	<0.024	<0.021	<0.024	
FLUORANTHENE	MG/KG	0.02	<0.024	<0.024	<0.021	<0.024	
FLUORENE	MG/KG	0.017	<0.024	<0.02	<0.017	<0.024	
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	0.032	<0.02	<0.017	<0.02	
NAPHTHALENE	MG/KG	0.02	3.4	<0.036	<0.031	<0.036	
PHENANTHRENE	MG/KG	0.017	<0.02	2.7	0.41	0.06	
PYRENE	MG/KG	0.017	<0.02	<0.02	<0.017	<0.02	
<b>Surrogates:</b>							
CARBAZOLE (37 - 153 % R)	%	1.0	119	101	89	90	
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	540	270	79	80	
<b>Dilution Factor:</b>							
	--	--	1	1	1	1	

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	SS03HA1556 Sample Date: 03/15/94 Sample Depth: 5-6'	SS03HA1656 03/15/94 5-6'	SS03HA1756 03/15/94 5-6'	SS03HA1845 03/14/94 4-5'
<u>D2216/Soil Moisture:</u> MOISTURE	MG/KG	--	18	18	5	17
<u>M8015/Semi-Volatiles (c):</u> DIESEL COMPONENTS	MG/KG	10	860 (JP-4)	420 (JP-5)	190 (JP-5)	<10
<u>Surrogate:</u> o-TERPHENYL (60 - 149 % R)	%	1.0	78	67	98	69
<u>Dilution Factor:</u>	--	--	21	21	11	1

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

-- Not analyzed.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based on QC data.

JD - Estimated quantitation based on dilution.

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/14/94 Sample Depth: 5-6'	Sample SS03HA2045 03/14/94 4-5'	Duplicate SS03HADUP1 03/20/94 4-5'	SS03HA2156 03/14/94 5-6'
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	MG/KG	0.0005	<0.025P J	<0.0005P	<0.0005P	0.28P
ETHYLBENZENE	MG/KG	0.0005	0.45P J	<0.0005P	<0.0005P	1.1P
M,P - XYLENE (SUM OF ISOMERS)	MG/KG	0.001	1.8P J	<0.001P	<0.001P	6.2P JD*
TOLUENE	MG/KG	0.0005	<0.025P J	0.0025P J	0.0068P J	<0.05P
<u>Surrogates:</u>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	135P	100P	98P	113P
FLUOROBENZENE (77 - 125 % R)	%	1.0	68P	103P	105P	80P
<u>Dilution Factor:</u>						
	--	--	50	1	1	*500/100
<u>SW8310/PAHs:</u>						
ACENAPHTHENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
BENZO(a)PYRENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
BENZO(g,h,i)PERYLENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
BENZO(k)FLUORANTHENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
CHRYSENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
FLUORANTHENE	MG/KG	0.02	<0.027	<0.025	<0.024	<0.024
FLUORENE	MG/KG	0.017	<0.022	<0.021	<0.02	<0.02
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	<0.04	<0.037	<0.036	<0.036
NAPHTHALENE	MG/KG	0.02	0.18	<0.025	0.042	0.77
PHENANTHRENE	MG/KG	0.017	<0.022	<0.021	<0.02	<0.02
PYRENE	MG/KG	0.017	<0.022	<0.021	<0.02	<0.02
<u>Surrogates:</u>						
CARBAZOLE (37 - 153 % R)	%	1.0	93	85	95	93
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	126	63	65	77
<u>Dilution Factor:</u>						
	--	--	1	1	1	1



TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	SS03HA1956 Sample Date: 03/14/94 Sample Depth: 5-6'	Sample SS03HA2045 03/14/94 4-5'	Duplicate SS03HADUP1 03/20/94 4-5'	SS03HA2156 03/14/94 5-6'
<u>D2216/Soil Moisture:</u>						
MOISTURE	MG/KG	--	15	20	17	17
<u>M8015/Semi-Volatiles (c):</u>						
DIESEL COMPONENTS	MG/KG	10	640 (JP-4)	<12	<11	260 (JP-4)
<u>Surrogate:</u>						
o-TERPHENYL (60 - 149 % R)	%	1.0	81	66	79	85
<u>Dilution Factor:</u>						
	--	--	200	1	1	11

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.  
 (b) - Results for this method are listed as: Primary/first column/second column.  
 (c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.  
 P - Primary result.  
 -- Not analyzed.  
 \* - Dilution specific to compound indicated.  
 J - Estimated quantitation based on QC data.  
 JD - Estimated quantitation based on dilution.

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/14/94 Sample Depth: 4-5'	SS03HA2245 03/14/94 5-6'	SS03HA2356 03/14/94 5-6'	SS03HA2456 03/14/94 5-6'	SS03HA2556 03/14/94 5-6'
<u>SW8020/Aromatic Volatiles (b):</u>							
BENZENE	MG/KG	0.0005	0.82P JD	2.4P JD	<0.1P	<0.13P JD	
ETHYLBENZENE	MG/KG	0.0005	4.3P JD	28P JD	0.5P	12P JD	
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	11P JD	73P JD	0.43P	15P JD	
TOLUENE	MG/KG	0.0005	<0.25P JD	1.9P JD	<0.1P	<1.3P JD	
<u>Surrogates:</u>							
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	115P	133P	96P	143P	
FLUOROBENZENE (77 - 125 % R)	%	1.0	80P	88P	93P	78P	
<u>Dilution Factor:</u>							
	--	--	500	2000	25	500	
<u>SW8310/PAHs:</u>							
ACENAPHTHENE	MG/KG	0.02	<0.026	<0.026	<0.026	<0.026	
BENZO(a)ANTHRACENE	MG/KG	0.02	0.55	<0.026	<0.026	<0.026	
BENZO(a)PYRENE	MG/KG	0.02	1.6	<0.026	<0.026	<0.026	
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.026	<0.026	<0.026	<0.026	
BENZO(g,h,i)PERYLENE	MG/KG	0.02	1.6	<0.026	<0.026	<0.026	
BENZO(k)FLUORANTHENE	MG/KG	0.02	0.69	<0.026	<0.026	<0.026	
CHRYSENE	MG/KG	0.02	0.93	<0.026	<0.026	<0.026	
FLUORANTHENE	MG/KG	0.02	<0.026	<0.026	<0.026	<0.026	
FLUORENE	MG/KG	0.017	<0.022	<0.022	0.13	2.2	
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	2.1	<0.039	0.046	<0.038	
NAPHTHALENE	MG/KG	0.02	7.1*	5.0*	0.094	4.0*	
PHENANTHRENE	MG/KG	0.017	2.2	<0.022	<0.021	9.6*	
PYRENE	MG/KG	0.017	0.47	<0.022	<0.021	<0.021	
<u>Surrogates:</u>							
CARBAZOLE (37 - 153 % R)	%	1.0	153	101	93	98	
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	435	310	96	1400	
<u>Dilution Factor:</u>							
	--	--	* 11	* 11	1	* 11	

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/14/94 Sample Depth: 4-5'	SS03HA2245 03/14/94 5-6'	SS03HA2356 03/14/94 5-6'	SS03HA2456 03/14/94 5-6'	SS03HA2556 03/14/94 5-6'
D2216/Soil Moisture: MOISTURE	MG/KG	--	23	23	22	23	23
M8015/Semi-Volatiles (c): DIESEL COMPONENTS	MG/KG	10	870 (JP-4)	1800 (JP-4)	<140	680 (JP-4)	
Surrogate: o-TERPHENYL (80 - 149 % R)	%	1.0	88	0	60	72	
Dilution Factor:	--	--	21	51	11	51	

- (a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.  
 (b) - Results for this method are listed as: Primary/first column/second column.  
 (c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.  
 P - Primary result.  
 -- Not analyzed.  
 \* - Dilution specific to compound indicated.  
 J - Estimated quantitation based on QC data.  
 JD - Estimated quantitation based on dilution.

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/27/94 Sample Depth: 3-4'	SS03HA2634 03/27/94 3-4'	SS03HA2734 03/27/94 3-4'	SS03HA2834 03/27/94 3-4'	SS03HA2912 03/27/94 1-2'
<b>SW8020/Aromatic Volatiles (b):</b>							
BENZENE	MG/KG	0.0005					
ETHYLBENZENE	MG/KG	0.0005	<0.0025P		0.027P	0.0058P	<5.0P JD
M,P -XYLENE (SUM OF ISOMERS)	MG/KG	0.001	0.012P	0.059P	0.059P	0.007P	14P JD
TOLUENE	MG/KG	0.0005	0.06408P JH	0.24P	0.24P	0.011P	48P JD
			0.01642P	0.053P	0.053P	0.027P	<5.0P JD
<b>Surrogates:</b>							
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	133P	105P	105P	108P	123P
FLUOROBENZENE (77 - 125 % R)	%	1.0	95P	98P	98P	100P	98P
	--	--	5	50	5	10000	
<b>Dilution Factor:</b>							
<b>SW8310/PAHs:</b>							
ACENAPHTHENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
BENZO(a)ANTHRACENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
BENZO(a)PYRENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
BENZO(g,h,i)PERYLENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
BENZO(k)FLUORANTHENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
CHRYSENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
FLUORANTHENE	MG/KG	0.02	<0.022	<0.024	<0.023	<0.023	<0.022
FLUORENE	MG/KG	0.017	<0.019	<0.02	<0.019	<0.019	<0.019
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	<0.034	<0.036	<0.034	<0.034	<0.034
NAPHTHALENE	MG/KG	0.02	0.2 JH	0.025	0.036	0.036	13*
PHENANTHRENE	MG/KG	0.017	<0.019	<0.02	<0.019	<0.019	<0.019
PYRENE	MG/KG	0.017	<0.019	<0.02	<0.019	<0.019	<0.019
<b>Surrogates:</b>							
CARBAZOLE (37 - 153 % R)	%	1.0	102	101	97	125	
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	76	86	63	920	
	--	--	1	1	1	* 11	
<b>Dilution Factor:</b>							

TABLE 5

HAND AUGER SOIL SAMPLES POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/27/94 Sample Depth: 3-4'	SS03HA2634 03/27/94 3-4'	SS03HA2734 03/27/94 3-4'	SS03HA2834 03/27/94 3-4'	SS03HA2912 03/27/94 1-2'
<u>D2216/Soil Moisture:</u> MOISTURE	MG/KG	--	11	17	12	11	
<u>M8015/Semi-Volatiles (c):</u> DIESEL COMPONENTS	MG/KG	10	11 (JP-4)	<12	<11	12000 (JP-5)	
<u>Surrogate:</u> o-TERPHENYL (80 - 149 % R)	%	1.0	77	85	82	110	
<u>Dilution Factor:</u>	--	--	1	1	1	51	

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

- T Not analyzed.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based on QC data.

JD - Estimated quantitation based on dilution.

**GROUND WATER SAMPLE ANALYTICAL RESULTS**

**APRIL, 1994**

GROUND-WATER POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION	Sample Date: 04/05/94	GM33	GM34	GM35	GM36	GM44	Background SS03GW01 04/05/94
LIMIT (a)									
<u>SW8020/Aromatic Volatiles (b):</u>									
BENZENE	UG/L	0.5	<0.5	<0.5	<0.5	<0.5P	<0.5P	<0.5	<0.5
ETHYLBENZENE	UG/L	0.5	<0.5	<0.5	<0.5	3.6P	7.2P	<0.5	<0.5
M,P-XYLENE (SUM OF ISOMERS)	UG/L	1.0	<1.0	<1.0	<1.0	18P JH	140P JH*	<1.0	<1.0
TOLUENE	UG/L	0.5	<0.5	<0.5	<0.5	<0.5P	<0.5P	<0.5	<0.5
<u>Surrogates:</u>									
4-CHLOROTOLUENE (88 - 118 % R)	%	1.0	103	103	103	123P	173P	103	103
FLUOROBENZENE (90 - 111 % R)	%	1.0	103	103	103	88P	98P	103	103
<u>Dilution Factors:</u>									
--	--	--	1	1	1	*10	*	1	1
<u>SW8310/PAHs:</u>									
NAPHTHALENE	UG/L	0.6	<0.7	<0.7	<0.7	<0.7	22	<0.7	<0.6
<u>Surrogates:</u>									
CARBAZOLE (47 - 144 % R)	%	1.0	98	102	108	108	105	102	110
DECARLUOROBIPHENYL (15 - 88 % R)	%	1.0	34	38	38	38	33	31	41
<u>Dilution Factor:</u>									
--	--	--	1	1	1	1	1	1	1
<u>M8015/Semi - Volatiles (c):</u>									
DIESEL COMPONENTS	MG/L	0.20	<0.22	<0.22	<0.22	<0.24	<0.21	<0.24	<0.22
<u>Surrogate:</u>									
o-TERPHENYL (42 - 161 % R)	%	1.0	108	108	108	115	118	108	108
<u>SW7421/Total Lead:</u>									
LEAD	MG/L	0.001	<0.001	0.0081	<0.001	<0.001	<0.001	<0.001	0.0037

(a) - Detection/Quantitation limits listed are "Ideal". Sample specific limits may vary by sample volume and/or dilution factors.  
(b) - Results for this method are listed as: Primary/first column/second column.  
(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.  
P - Primary result.  
\* - Dilution specific to compound indicated.  
JH - Estimated quantitation - possibly biased high based upon QC data.  
TPH - Total Petroleum Hydrocarbons.  
NS - Not sampled; pure product present in well.

GROUND-WATER POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample SS03GW03 04/07/94	Duplicate SS03GWDUP2 04/07/94	SS03GW04	SS03GW05
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	UG/L	0.5	5.9P	5.1P	NS	NS
ETHYLBENZENE	UG/L	0.5	0.73P	0.73P	NS	NS
M,P-XYLENE (SUM OF ISOMERS)	UG/L	1.0	<1.0	<1.0	NS	NS
TOLUENE	UG/L	0.5	<0.5	<0.5	NS	NS
<u>Surrogates:</u>						
4-CHLOROTOLUENE (88 - 118 % R)	%	1.0	103P	100	NS	NS
FLUOROBENZENE (90 - 111 % R)	%	1.0	98P	100	NS	NS
<u>Dilution Factors:</u>						
	--	--	1	1	NS	NS
<u>SW8310/PAHs:</u>						
NAPHTHALENE	UG/L	0.6	<0.9	<0.6	NS	NS
<u>Surrogates:</u>						
CARBAZOLE (47 - 144 % R)	%	1.0	106	110	NS	NS
DECAFLUOROBIPHENYL (15 - 88 % R)	%	1.0	34	94	NS	NS
<u>Dilution Factor:</u>						
	--	--	1	1	NS	NS
<u>M8015/Seml - Volatiles (c):</u>						
DIESEL COMPONENTS	MG/L	0.20	<0.22	<0.21	NS	NS
<u>Surrogate:</u>						
o-TERPHENYL (42 - 161 % R)	%	1.0	117	100	NS	NS
<u>SW7421/Total Lead:</u>						
LEAD	MG/L	0.001	0.0012	<0.001	NS	NS

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

JH - Estimated quantitation - possibly biased high based upon QC data.

TPH - Total Petroleum Hydrocarbons.

NS - Not sampled; pure product present in well.



GROUND-WATER POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample SS03GW06 Sample Date: 04/06/94	Duplicate SS03GWDUP1 04/06/94	SS03GW07 04/06/94	SS03GW08 04/06/94	SS03GW09 04/06/94
<u>SW8020/Aromatic Volatiles (b):</u>							
BENZENE	UG/L	0.5	400P*	440P	<0.5	<0.5	<0.5
ETHYLBENZENE	UG/L	0.5	280P*	300P	<0.5	<0.5	<0.5
M,P-XYLENE (SUM OF ISOMERS)	UG/L	1.0	3100P*	3100P	<1.0	<1.0	<1.0
TOLUENE	UG/L	0.5	47P	63P	<0.5	<0.5	<0.5
<u>Surrogates:</u>							
4-CHLOROTOLUENE (88 - 118 % R)	%	1.0	105P	105P	103	100	100
FLUOROBENZENE (90 - 111 % R)	%	1.0	98P	100P	100	100	100
<u>Dilution Factors:</u>							
	--	--	*100 / 1	100	1	1	1
<u>SW8310/PAHs:</u>							
NAPHTHALENE	UG/L	0.6	130 *	160 *	<0.6	<0.6	<0.6
<u>Surrogates:</u>							
CARBAZOLE (47 - 144 % R)	%	1.0	111	108	95	111	107
DECARLUOROBIPHENYL (15 - 88 % R)	%	1.0	32	44	31	40	39
<u>Dilution Factor:</u>							
	--	--	*6	*6	1	1	1
<u>M8015/Seml - Volatiles (c):</u>							
DIESEL COMPONENTS	MG/L	0.20	0.56	0.55	<0.23	<0.24	<0.24
<u>Surrogate:</u>							
o-TERPHENYL (42 - 161 % R)	%	1.0	100	100	85	92	92
<u>SW7421/Total Lead:</u>							
LEAD	MG/L	0.001	0.0047 J	0.007 J	<0.001	<0.001	0.0017

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

(c) - Results are quantitated as gasoline or diesel but may be identified as another fuel.

P - Primary result.

\* - Dilution specific to compound indicated.

JH - Estimated quantitation - possibly biased high based upon QC data.

TPH - Total Petroleum Hydrocarbons.

NS - Not sampled; pure product present in well.

GROUND-WATER POSITIVE ANALYTICAL RESULTS, APRIL 1994  
LAW ENVIRONMENTAL NATIONAL LABS  
POL Area  
Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 04/06/94	SS03GW10	SS03GW11 04/06/94
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	UG/L	0.5		<0.5P	350P*
ETHYLBENZENE	UG/L	0.5		<0.5P	98P
M,P-XYLENE (SUM OF ISOMERS)	UG/L	1.0		1.8P	2400P*
TOLUENE	UG/L	0.5		<0.5P	<5.0P
<u>Surrogates:</u>					
4-CHLOROTOLUENE (88 - 118 % R)	%	1.0		103P	105P
FLUOROBENZENE (90 - 111 % R)	%	1.0		103P	100P
<u>Dilution Factors:</u>					
	--	--		1	*100 / 10
<u>SW8310/PAHs:</u>					
NAPHTHALENE	UG/L	0.6		0.7	<0.6
<u>Surrogates:</u>					
CARBAZOLE (47 - 144 % R)	%	1.0		110	115
DECARLUOROBIPHENYL (15 - 88 % R)	%	1.0		42	41
<u>Dilution Factor:</u>					
	--	--		1	1
<u>M8015/Seml - Volatiles (c):</u>					
DIESEL COMPONENTS	MG/L	0.20		<0.24	<0.21
<u>Surrogate:</u>					
o-TERPHENYL (42 - 161 % R)	%	1.0		92	100
<u>SW7421/Total Lead:</u>					
LEAD	MG/L	0.001		0.0045	0.003

(a) -- Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) -- Results for this method are listed as: Primary/first column/second column.

(c) -- Results are quantitated as gasoline or diesel but may be identified as another fuel.

P -- Primary result.

\* -- Dilution specific to compound indicated.

JH -- Estimated quantitation - possibly biased high based upon QC data.

TPH -- Total Petroleum Hydrocarbons.

NS -- Not sampled; pure product present in well.

**SURFACE WATER ANALYTICAL RESULTS**

**APRIL, 1994**

TABLE 7

SURFACE WATER POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Upstream SS03SW01 Sample Date: 03/23/94 Sample Depth:	SS03SW02 03/23/94	Sample SS03SW03 03/23/94	Duplicate SS03SWDUP 03/23/94
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	UG/L	0.5	13P	<0.5P	76P J	180P J
ETHYLBENZENE	UG/L	0.5	1.6P	<0.5P	15P	25P
M,P - XYLENE (SUM OF ISOMERS)	UG/L	1.0	11P	<1.0P	260P J	590P J*
TOLUENE	UG/L	0.5	24P*	<0.5P	5.6P	6.6P
Surrogates:						
4-CHLOROTOLUENE (88 - 118 % R)	%	1.0	103P	103P	105P	110P
FLUOROBENZENE (90 - 111 % R)	%	1.0	100P	100P	100P	100P
<u>Dilution Factor:</u>						
	--	--	*10	1	10	*100 / 10
<u>SW8310/PAHs:</u>						
NAPHTHALENE	UG/L	0.6	<0.7	<0.7	13	19
Surrogates:						
CARBAZOLE (47 - 144 % R)	%	1.0	94	110	105	104
DECAFLUOROBIPHENYL (15 - 88 % R)	%	1.0	41	59	53	53
<u>Dilution Factor:</u>						
	--	--	1	1	1	1
<u>SW7421/Total Lead:</u>						
LEAD	MG/L	0.001	0.0019	<0.001	0.0028 J	0.0081 J

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

NA - NA - Not analyzed.

TABLE 7

SURFACE WATER POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Area  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/23/94 Sample Depth:	SS03SW04 03/23/94	SS03SW05 03/23/94
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	UG/L	0.5	5.0P	4.4P	
ETHYLBENZENE	UG/L	0.5	0.9P	0.91P	
M,P - XYLENE (SUM OF ISOMERS)	UG/L	1.0	17P	17P	
TOLUENE	UG/L	0.5	<0.5P	<0.5P	
Surrogates:					
4-CHLOROTOLUENE (88 - 118 % R)	%	1.0	105P	105P	
FLUOROBENZENE (90 - 111 % R)	%	1.0	100P	100P	
<u>Dilution Factor:</u>					
	--	--	1	1	
<u>SW8310/PAHs:</u>					
NAPHTHALENE	UG/L	0.6	<0.7	<0.7	
Surrogates:					
CARBAZOLE (47 - 144 % R)	%	1.0	97	103	
DECAFLUOROBIPHENYL (15 - 88 % R)	%	1.0	49	50	
<u>Dilution Factor:</u>					
	--	--	1	1	
<u>SW7421/Total Lead:</u>					
LEAD	MG/L	0.001	<0.001	<0.001	

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

NA - NA - Not analyzed.

TABLE 8

SEDIMENT POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Areas  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION	Upstream		Sample	Duplicate
			SS03SD01	SS03SD02	SS03SD03	SS03SD04
		LIMIT (a)	Sample Date: 03/23/94	Sample Date: 03/23/94	Sample Date: 03/23/94	Sample Date: 03/23/94
			Sample Depth: 0-0.5'	Sample Depth: 0-0.5'	Sample Depth: 0-0.5'	Sample Depth: 0-0.5'
<u>SW8020/Aromatic Volatiles (b):</u>						
BENZENE	MG/KG	0.0005	<0.0005	<0.0005	<0.013P J	0.14P J
ETHYLBENZENE	MG/KG	0.0005	<0.0005	<0.0005	0.14P J	0.32P J
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001	<0.001	<0.001	1.6P JH*	4.0P JD*
<u>Surrogates:</u>						
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0	105	105	200P	158P
FLUOROBENZENE (77 - 125 % R)	%	1.0	98	105	100P	100P
<u>Dilution Factor:</u>						
	--	--	1	1	*100 / 25	*1000 / 100
<u>SW8310/PAHs:</u>						
ACENAPHTHENE	MG/KG	0.02	0.026	0.3	<0.028	<0.027
ANTHRACENE	MG/KG	0.027	<0.034	0.098	<0.037	<0.036
BENZO(a)ANTHRACENE	MG/KG	0.02	0.14	1.3	0.092	0.081
BENZO(a)PYRENE	MG/KG	0.02	0.2	2.2	0.23	0.15
BENZO(b)FLUORANTHENE	MG/KG	0.02	<0.028	2.6	0.63	0.69
BENZO(g,h,i)PERYLENE	MG/KG	0.02	0.16	1.7	0.16	0.20
BENZO(k)FLUORANTHENE	MG/KG	0.02	0.12	1.4	0.11	0.12
CHRYSENE	MG/KG	0.02	0.18	2.2	0.15	0.13
FLUORANTHENE	MG/KG	0.02	0.37	4.2	0.27	0.22
FLUORENE	MG/KG	0.017	<0.021	0.23	<0.023	<0.023
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03	0.22	2.4	0.24	0.26
NAPHTHALENE	MG/KG	0.02	<0.026	0.14	0.52	0.71
PHENANTHRENE	MG/KG	0.017	0.12	1.6	0.11	0.13
PYRENE	MG/KG	0.017	0.3	3.6	0.23	0.2
<u>Surrogates:</u>						
CARBAZOLE (37 - 153 % R)	%	1.0	109	120	110	106
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0	97	66	81	80
<u>Dilution Factor:</u>						
	--	--	1	1	1	1
<u>SW7421/Total Lead:</u>						
LEAD	MG/KG	1.0	290	74	15 J	45 J

**SEDIMENT ANALYTICAL RESULTS**

**APRIL, 1994**

TABLE 8

SEDIMENT POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Areas  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Upstream		Sample		Duplicate
			SS03SD01 03/23/94 0-0.5'	SS03SD02 03/23/94 0-0.5'	SS03SD03 03/23/94 0-0.5'	SS03SDDUP 03/23/94 0-0.5'	
<u>Dilution Factor:</u>							
<u>D2216/Soil Moisture:</u> MOISTURE	--	--	50	10	2	1	
	%	--	22	41	22	27	

(a) - Detection/Quantitation limits listed are "ideal". Sample specific limits may vary by sample volume and/or dilution factors.

(b) - Results for this method are listed as: Primary/first column/second column.

P - Primary result.

\* - Dilution specific to compound indicated.

J - Estimated quantitation based upon QC data.

JH - Estimated quantitation - possibly biased high based on QC data.

JD - Estimated due to dilution.



TABLE 8

SEDIMENT POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Areas  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/23/94 Sample Depth: 0-0.5'	SS03SD04	SS03SD05 03/23/94 0-0.5'
<u>SW8020/Aromatic Volatiles (b):</u>					
BENZENE	MG/KG	0.0005			
ETHYL BENZENE	MG/KG	0.0005			
M,P-XYLENE (SUM OF ISOMERS)	MG/KG	0.001			
<u>Surrogates:</u>					
4-CHLOROTOLUENE (79 - 124 % R)	%	1.0		105	103
FLUOROBENZENE (77 - 125 % R)	%	1.0		120	120
<u>Dilution Factor:</u>					
	--	--		1	1
<u>SW8310/PAHs:</u>					
ACENAPHTHENE	MG/KG	0.02		<0.037	0.073
ANTHRACENE	MG/KG	0.027		<0.049	<0.046
BENZO(a)ANTHRACENE	MG/KG	0.02		0.12	0.36
BENZO(a)PYRENE	MG/KG	0.02		0.28	0.55
BENZO(b)FLUORANTHENE	MG/KG	0.02		<0.037	<0.034
BENZO(g,h,i)PERYLENE	MG/KG	0.02		<0.037	0.57
BENZO(k)FLUORANTHENE	MG/KG	0.02		0.11	0.39
CHRYSENE	MG/KG	0.02		0.24	0.74
FLUORANTHENE	MG/KG	0.02		0.43	1.2
FLUORENE	MG/KG	0.017		<0.031	<0.029
INDENO(1,2,3-c,d)PYRENE	MG/KG	0.03		0.28	0.76
NAPHTHALENE	MG/KG	0.02		<0.037	<0.034
PHENANTHRENE	MG/KG	0.017		0.12	0.32
PYRENE	MG/KG	0.017		0.37	1.1
<u>Surrogates:</u>					
CARBAZOLE (37 - 153 % R)	%	1.0		103	110
DECAFLUOROBIPHENYL (D - 121 % R)	%	1.0		75	117
<u>Dilution Factor:</u>					
	--	--		1	1
<u>SW7421/Total Lead:</u>					
LEAD	MG/KG	1.0		18	61

TABLE 8

SEDIMENT POSITIVE ANALYTICAL RESULTS, APRIL 1994  
 LAW ENVIRONMENTAL NATIONAL LABS  
 POL Areas  
 Former Myrtle Beach AFB, South Carolina

METHOD/ANALYTE	UNITS	DETECTION/ QUANTITATION LIMIT (a)	Sample Date: 03/23/94 Sample Depth: 0-0.5'	
			SS03SD04	SS03SD05
D2216/Soil Moisture:	--	--	1	10
MOISTURE	%	--	46	42

Dilution Factor:

D2216/Soil Moisture:  
MOISTURE

- (a) - Detection/Quantitation limits listed are "Ideal". Sample specific limits may vary by sample volume and/or dilution factors.  
 (b) - Results for this method are listed as: Primary/first column/second column.  
 P - Primary result.  
 \* - Dilution specific to compound indicated.  
 J - Estimated quantitation based upon QC data.  
 JH - Estimated quantitation - possibly biased high based on QC data.  
 JD - Estimated due to dilution.